Cumulative Effects Assessment Practitioners Guide

Prepared for:
Canadian Environmental Assessment Agency

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DISCLAIMER

This Guide was developed by an independent Working Group supported by the Canadian Environmental Assessment Agency (the Agency). The Guide provides insightful information and advocates good cumulative effects assessment practices. It is to be used as guidance material only. Users of the Guide should consult with the appropriate decision-making authority for which the environmental assessment is undertaken for further information on assessment requirements specific to applicable statutory requirements and expected best practice.

RELATIONSHIP TO FIRST CEAA GUIDE ON CUMULATIVE EFFECTS

In 1994, the Agency published *A Reference Guide for the Canadian Environmental Assessment Act: Addressing Cumulative Environmental Effects*. This publication was available as part of the Agency's *The Canadian Environmental Assessment Act Training Compendium* or under separate cover. That Reference Guide formed the basis of the Agency's response to questions about conducting Cumulative Effects Assessments, and has been widely used and referenced. The Agency has updated the 1994 Reference Guide on Cumulative Environmental Effects to reflect evolving processes and methods to meet requirements under the Canadian Environmental Assessment Act.

The *Practitioners Guide* you are now reading represents a CEAA initiative to provide further information on cumulative effects. This Guide is focussed on practical solutions for practitioners conducting Cumulative Effects Assessments and should be considered a supplement, not a replacement, to the Reference Guide.

RELATIONSHIP TO THE CANADIAN ENVIRONMENTAL ASSESSMENT ACT

The Canadian Environmental Assessment Agency has developed a four page policy paper on the Agency's position regarding CEAs under the *Canadian Environmental Assessment Act*. This Operational Policy Statement is entitled *Addressing Cumulative Effects under the Canadian Environmental Assessment Act*. The policy document does not recount what is contained in the *Practitioners Guide* but provides the Agency's view on CEA under the Act and the use of this Guide by federal authorities.

COMMENTS ABOUT THIS GUIDE

This document is an evolving product and is not the "final word" on CEA. It will be updated and revised as the practice of CEA evolves. The CEA Working Group and the Canadian Environmental Assessment Agency welcome comments and suggestions regarding this Guide. These should be addressed to: Senior Guidance and Training Officer, Canadian Environmental Assessment Agency, 13th Floor, Fontaine Building, 200 Sacré-Coeur Boulevard, Hull, Quebec, K1A 0H3; or Fax to (819)-997-4931; or E-mail to training/formation@ceaa.gc.ca.

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PREFACE

In late 1996, the Canadian Environmental Assessment Agency assembled an independent Working Group[1] of specialists on Environmental Impact Assessment and Cumulative Effects Assessment to provide further practical direction and information to practitioners on assessing cumulative effects. Based on direction, editorial comment and material provided by the Working Group, the Agency contracted AXYS Environmental Consulting Ltd. to prepare this Guide

The Guide represents the result of a collaborative effort between the Agency and the Working Group. Public consultation sessions were also held by the Agency in the winter of 1998 to solicit comment on a Discussion Draft released in December 1997 for public review. Due to the breadth of comments, not all could be addressed.

Thanks go to Patricia Vonk and Jeffrey Green of AXYS Environmental Consulting Ltd. for technical review and edit of early drafts. Special thanks to Sylvie Dupuis for her ongoing interest and support in initiating and facilitating the Working Group in the first year as a member of the Canadian Environmental Assessment Agency, to Catherine Badke of the Agency for chairing the Working Group in the second year, and to Robyn Virtue and Brad Parker of the Agency for overseeing final production of the Guide.

Also thanks to the many members of the Canadian public who provided comments about the Guide during the public consultation sessions. The extensive oral and written comments contributed to considerable improvements in later versions of the Guide.

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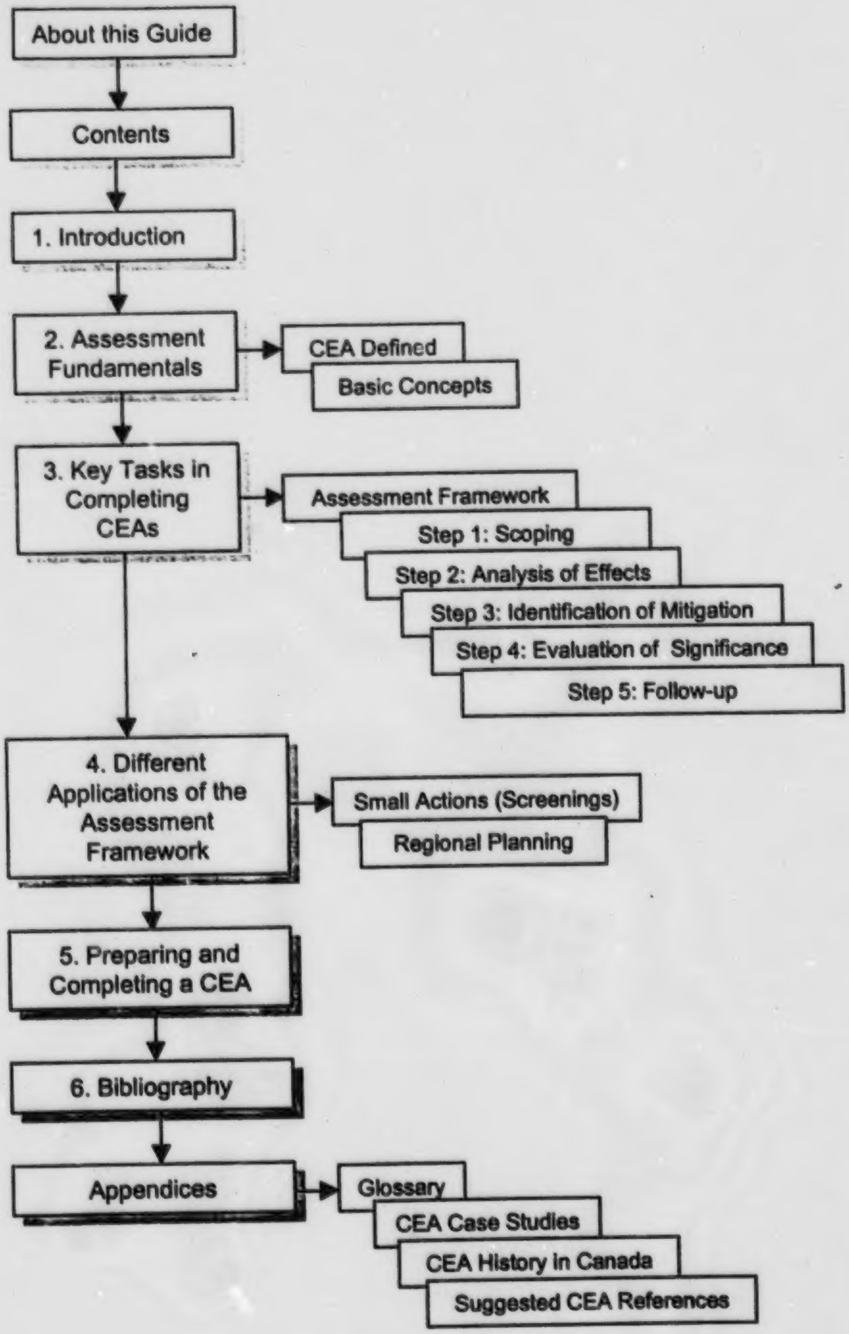
FINDING YOUR WAY IN THE GUIDE

The following illustrates the major chapters and sub-sections within this Guide. Use this to find material of interest to you.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ABOUT THIS GUIDE

WHO IS THIS GUIDE INTENDED FOR?

This Guide is intended primarily for practitioners who are responsible for preparing Cumulative Effects Assessments (CEAs) as part of a submission to appropriate regulatory bodies for project review. "Practitioners" include consultants, government agencies and proponents. The Guide may also be useful to regulatory bodies and review panels in recognizing what constitutes acceptable and reasonable practice regarding CEAs and in developing appropriate Terms of Reference for the assessments.

WHAT IS THE PURPOSE OF THIS GUIDE?

The purpose of this Guide is to provide practitioners with:

- an overview and clarification of current understanding about the practice of CEA;
- suggestions on practical approaches to complete CEAs that meet statutory requirements and best professional practice; and
- case studies of approaches used by project proponents for their CEAs.

IS WHAT IS SAID IN THIS GUIDE MANDATORY?

The Guide does not describe mandatory requirements for completion of CEAs. The only few exceptions relate to requirements specifically under the *Canadian Environmental Assessment Act*. This Guide is meant to be generic to any legislated assessment process and to assist practitioners through the provision of background information on CEAs, suggestions for possible approaches and examples through the use of case studies. Case studies are a central component of this Guide, and reflects the CEA Working Group's belief that case studies, where one learns from what others have done, are one of the most instructive ways of learning about CEA. Appearance of a case study does not in any way imply an endorsement by the Working Group or the Canadian Environmental Assessment Agency or mandatory requirement of the approaches used or decisions made.

WHAT DOES THIS GUIDE NOT COVER?

The Guide assumes the user has a basic knowledge of Environmental Impact Assessment (EIA) fundamentals. This includes such topics as issues scoping, identification and use of Valued Ecosystem Components (VECs), use of indicators, analytical techniques, determining significance and identifying mitigation. This knowledge is important, as many attributes of CEAs are based on those originally developed for EIAs over the past years.

In the interest of keeping the Guide focussed on the practical needs of the practitioner, the Guide does not attempt to cover all aspects of CEA. The scope of this Guide is, therefore, subject to the following limitations:

- ***Canadian federal versus provincial environmental assessment legislation***: The Guide does not restrict itself to CEA requirements as specified under any particular legislation. The extent to which principles described in this Guide apply may vary among jurisdictions depending on the particular legislation in force. In this way, the Guide is largely generic, and provides information that is useful for CEAs performed under any jurisdiction. However, in some instances specific reference to the *Canadian Environmental Assessment Act* is made regarding statutory requirements and interpretations. The Canadian Environmental

Assessment Agency's Reference Guide on Cumulative Environmental Effects provides specific details on mandatory and recommended requirements under the Act.

- ***Biophysical versus socio-economic effects***: This Guide focusses on the assessment of biophysical as opposed to socio-economic effects (the latter includes heritage resources and resource use). Although considerable progress has been made in the development of assessment tools for socio-economic impact assessment, most available information on approaches and examples of CEAs focus on biophysical effects. Cumulative socio-economic effects are often included within a separate Socio-economic Impact Assessment using conventional techniques of assessment. In some ways, Socio-economic Impact Assessments often include cumulative effects issues because of their typically broad regional view of effects, and the use of standardized Valued Social Components (VSCs) or indicators representative of regional changes (e.g., monetary value, workforce size). The advancement of CEA practice should include more frequent recognition of social consequences and the connections between those consequences and the environment because environmental effects often lead to socio-economic effects (e.g., for resource use such as timber harvesting).
- ***Project-specific assessments versus regional planning***: The assessment of cumulative effects may be approached for two distinct purposes: project-specific assessments, and regional planning (or land use) studies.[2] The Guide addresses only project-specific assessments in detail; however, Section 4.2 briefly discusses regional studies and provides some examples. Project specific assessments are more common and are completed for single project applications for submission to an administrative agency. Regional planning studies examine effects that may occur as a result of many future human activities within a large region, often *before* actions commence in the region (i.e., they are *proactive* as opposed to *reactive*). However, these studies may be triggered by a single project (often the first project in the region) contributing to a concern about the long-term effects of further developments.
- ***Assessing the few large projects versus the many small projects***: Under the *Canadian Environmental Assessment Act*, a project may be reviewed at a simple "screening" level or at a more detailed level in a comprehensive study, mediation or panel review. For many regulatory agencies, the vast majority of project applications never proceed beyond a screening level review. Relatively few projects are assessed in more detail because of their small size and limited potential to cause significant effects or public concern.[3] Despite the greater number of screenings that are conducted, most of the existing information on CEA issues and approaches is intended for or is most applicable to larger projects where more resources (i.e., time, budget, staff) are available. Regarding assessment fundamentals, however, much of what is true for comprehensive studies (and mediation and panel reviews) is also true for screenings. Although the Guide focusses on CEA approaches and issues related to assessing the effects of large projects, the Guide does address cumulative effects assessment of smaller projects.
- ***Use of case studies***: The use of case studies reflects an adaptive and evolutionary approach whereby the practitioner can build on lessons learned from earlier assessments. Their use is based on the belief that one of the best ways to learn about CEA is to observe and improve on what others have done. While the case studies serve as examples of CEA practice so far, their inclusion in this Guide does not imply that these assessments represent "state-of-the-art".

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[2] Of a similar broad scope to regional studies is Strategic Environmental Assessment which provides an assessment of the environmental effects of policy decisions by administrators. This Guide does not examine such assessments.

[3] "Small" and "large" are imprecise terms. "Small" is generally understood to represent projects of quite limited geographic extent, with very localized effects that often can be fully mitigated by standard mitigation measures. "Large" projects do not share these restrictions, although it does occur on occasion that relatively large projects are completely assessed at a screening level.

CEA practice (and theory) is continually evolving. In the meantime, however, projects are being proposed and assessments must be done. In recognition of this, the Guide indicates what can practically be accomplished now, and points the way ahead to better professional practice in the assessment of cumulative effects.

- ***Discussion of assessment theory***: In recognition of the extensive amount of information currently available on the subject, the Guide provides literature references (Appendix D) for further information instead of providing extensive background theory or a detailed review of assessment methodologies.[4]
- ***Canadian versus international experience***: The Guide is limited to discussing issues from a Canadian perspective as much as possible and, therefore, largely reflects current Canadian practice.

USING THE INFORMATION BOXES

"Information Boxes" are used throughout the Guide to assist the reader in finding information on specific CEA issues, approaches and examples. A "List of Information Boxes" is also provided after the Table of Contents so that the reader may search for a specific topic. The boxes provide three different types of information:

- Explicit step-by-step instructions that describe a certain task.
- More detailed information on a subject.
- "Real-world" examples or "Case Studies" of assessments from which specific lessons can be learned (detailed descriptions of some of these are provided in Appendix B).

UNDERSTANDING THE REFERENCING

■ This symbol indicates that literature references on a specific subject covered in the text are provided in Appendix D (which is categorized by the referenced subject). Bibliographic references for citations in the Guide, however, are found in the Bibliography (Chapter 6).

➡ This symbol identifies another Section in the Guide that provides further information on the subject.

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[4] While much of the literature defines CEA and proposes methods, many goals suggested therein are not always attainable due to lack of data and poor knowledge of complex ecosystem process.

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1.0 INTRODUCTION

Concerns are often raised about the long-term changes that may occur not only as a result of a single action but the combined effects of each successive action on the environment. Cumulative Effects Assessment (CEA) is done to ensure the incremental effects resulting from the combined influences of various actions are assessed. These incremental effects may be significant even though the effects of each action, when independently assessed, are considered insignificant.

Assessment of cumulative effects is increasingly seen as representing best practice in conducting environmental assessments. Furthermore, in Canada, assessment of cumulative effects is now required in federal legislation when an action is subject to a federal environmental assessment under the *Canadian Environmental Assessment Act*. The Alberta *Environmental Protection and Enhancement Act* and the British Columbia *Environment Assessment Act* also include provisions for the assessment of cumulative effects.

A major concern of proponents is how to respond to increasing expectations by regulators and the public of what must be considered in a CEA and how a CEA is to be performed. When faced with determining an appropriate level of response, the proponent may ask the following questions, all of which are addressed in this Guide:

- How do we avoid assessing everything?
- How do we identify what is important to assess?
- How large an area around the action under review do we have to assess?
- What other actions should we consider?
- Over what duration of time must effects be assessed?
- How do we determine significance of these cumulative effects?
- What do we need to do about these cumulative effects?

The challenges in implementing CEAs are very similar to long-standing issues in Environmental Impact Assessment (EIA) practice. CEAs typically build upon existing methods and approaches to EIA. In recognition that there is not one single prescriptive method to conduct a CEA, this Guide demonstrates various approaches by way of example. It shows why and how certain methods or approaches have been used by practitioners to deal with cumulative environmental effects associated with selected actions and discusses what lessons can be learned. Practitioners may then choose an approach appropriate to meet their unique assessment requirements. These lessons can also provide the practitioner with tools for innovative thinking to further the evolving science and practice of CEA.

CEA Primers

1.1 THE BASICS OF DOING A CEA

The following summarizes some key points discussed in this Guide regarding implementation of a CEA, and serves as a summary to the approach suggested:[5]

- ☑ The study area is large enough to allow the assessment of Valued Ecosystem Components (VECs) that may be affected by the action being assessed. This may result in an area that is considerably larger than the action's "footprint". Each VEC may have a different study area.
- ☑ Other actions that have occurred, exist, or may yet occur which may also affect those same VECs are identified. Future actions that are approved within the study area must be considered; officially announced and reasonably foreseeable actions should be considered if they may affect those VECs and there is enough information about them to assess their effects. Some of these actions may be outside the study area if their influence extends for considerable distances and length of time.
- ☑ The incremental *additive* effects of the proposed action on the VECs are assessed. If the nature of the effects interaction is more complex (e.g., synergistic), then the effect is assessed on that basis, or why that is not reasonable or possible is explained.
- ☑ The total effect of the proposed action and other actions on the VECs are assessed.
- ☑ These total effects are compared to thresholds or policies, if available, and the implications to the VECs are assessed.
- ☑ The analysis of these effects use quantitative techniques, if available, based on best available data. This should be enhanced by qualitative discussion based on best professional judgement.
- ☑ Mitigation, monitoring and effects management are recommended (e.g., as part of an Environmental Protection Plan). These measures may be required at a regional scale (possibly requiring the involvement of other stakeholders) to address broader concerns regarding effects on VECs.
- ☑ The significance of residual effects are clearly stated and defended.

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[5] This list is also shown in Chapter 5 as the "Key Criteria for an Acceptable CEA".

2.0 ASSESSMENT FUNDAMENTALS

2.1 CUMULATIVE EFFECTS DEFINED

Cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future human actions.[6] A CEA is an assessment of those effects (➔ *"Actions" Include Projects and Activities*).

CEA is environmental assessment as it should always have been: an Environmental Impact Assessment (EIA) done well. In practice, the assessment of cumulative effects requires consideration of some concepts that are not always found in conventional approaches followed in EIAs. Specifically, CEAs are typically expected to:

- assess effects over a larger (i.e., "regional") area that may cross jurisdictional boundaries;[7]
- assess effects during a longer period of time into the past and future;
- consider effects on Valued Ecosystem Components (VECs) due to interactions with other actions, and not just the effects of the single action under review;
- include other past, existing and future (e.g., reasonably foreseeable) actions; and
- evaluate significance in consideration of other than just local, direct effects.

Cumulative effects are not necessarily that much different from effects examined in an EIA; in fact, they may be the same. Many EIAs have focussed on a local scale in which only the "footprint" or area covered by each action's component is considered. Some EIAs also consider the combined effects of various components together (e.g., a pulp mill and its access road). A CEA further enlarges the scale of the assessment to a regional level. For the practitioner, the challenge is determining how large an area around the action should be assessed, how long in time, and how to practically assess the often complex interactions among the actions. In all other ways, CEA is fundamentally the same as EIA and, therefore, often relies on established EIA practice.

■ ***Definitions and Concepts***

Conditions for Potential Cumulative Effects

Cumulative effects may occur if:

- local effects on VECs occur as a result of the action under review; and
- those VECs are affected by other actions.

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[6] Numerous definitions of CEAs exist in the literature. Many of these are quite complicated and refer to technical aspects of cumulative effect's interactions. The Working Group prefers a simple definition based on an important additional requirement of CEA as compared to EIA: the specific consideration of effects due to other projects. This definition is intended specifically for single-project assessments as opposed to regional planning (in which case there is not necessarily a single project that serves as the starting point and focus of the assessment), and borrows the broad definition of "environment" as used in the *Canadian Environmental Assessment Act*.

[7] Includes effects due to natural perturbations affecting environmental components and human actions.

Key Terms Defined

Action: Any project or activity of human origin.

Assessment Framework: A description of a process that organizes actions and ideas, usually in a step-by-step fashion. Frameworks help to guide practitioners in carrying out an assessment.

Effect: Any response by an environmental or social component to an action's impact[8].

Environmental Components: Fundamental elements of the natural environment. Components usually include air, water (surface and groundwater), soils, terrain, vegetation, wildlife, aquatics and resource use.

Region: Any area in which it is suspected or known that effects due to the action under review may interact with effects from other actions. This area typically extends beyond the local study area; however, as to how far will vary greatly depending on the nature of the cause-effect relationships involved.

Scoping: A consultative process for identifying and possibly reducing the number of items (e.g., issues, VECs) to be examined until only the most important items remain for detailed assessment. Focussing ensures that assessment effort will not be expended in the examination of trivial effects.

Threshold: A limit of tolerance of a VEC to an effect, that if exceeded, results in an adverse response by that VEC.

Valued Ecosystem Component (VEC): Any part of the environment that is considered important by the proponent, public, scientists and government involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concern.

"Actions" Include Projects and Activities

Human actions often cause a disturbance to the environment. These actions include projects and activities. Projects are typically some form of physical work that is planned, constructed and operated. Projects are usually identified by a specific name. Activities may be part of a project, or not associated with any particular project but arise over time due to ongoing human presence in an area. A mine development, a resource access road, or both together are examples of a project. Public traffic, hiking and hunting along that road are examples of activities.

For the purposes of a CEA, the effects on the environment of other projects and activities also have to be considered. For convenience, in this Guide, the term "Actions" is used when appropriate to represent both projects and activities. The term "project" is used only in reference to the project being proposed under assessment or under regulatory review.

In the *Canadian Environmental Assessment Act*, a project means "(a) in relation to a physical work, any proposed construction, operation, modification, decommissioning, abandonment, or other undertaking in relation to that physical work; or (b) any proposed physical activity not relating to a physical work that is prescribed or is within a class of physical activities that is prescribed pursuant to regulations made under paragraph 59(b) in the Act." The Act does not provide a definition for "activity"; however, it is commonly understood not to include a physical work. It is, therefore, considered in this Guide as any action that requires the presence, often temporary, of humans concentrated in a local area or dispersed over a large area.

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[8] Under the *Canadian Environmental Assessment Act*, "environmental effect" means, in respect of a project, "(a) any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance and (b) any change to the project that may be caused by the environment, whether any such change occurs within or outside of Canada".

Examples of Cumulative Effects

- **Air**: combined SO_2 emissions within a regional airshed from three operating natural-gas processing plants
- **Water**: combined reductions in flow volumes within a particular river resulting from irrigation, municipal and industrial water withdrawals
- **Wildlife**: combined black bear mortalities within a given wildlife management unit from hunter harvest, road kills and destruction of nuisance animals
- **Vegetation**: clearing of land resulting in the removal of a patch of regionally rare plant species
- **Resource Use**: continual removal of merchantable timber from a timber management area

CASE STUDY
Cold Lake Oil Sands Project: Effects at a Regional Scale

Imperial Oil Resources proposed the expansion of an in-situ heavy oil facility in northern Alberta (IORL 1997a, ➜ Appendix B). The following provides examples of some effects identified during early scoping exercises.

Environmental Component	Examples of Potential Regional Effects
Air Systems	Plumes from stack emissions combining with the plumes from nearby burns
Surface Water	Reductions of river water volumes due to use by the project, other energy projects and nearby communities
Aquatic Resources	Decrease in productivity of spawning habitat due to combined sedimentation from the project and regional forestry operations and activities
Soils and Terrain	Continued loss of soils
Vegetation	Less representation of certain plant species on a regional scale
Wildlife	Increased road access and changes to habitat resulting in further regional changes to numbers and distribution of certain wildlife species
Resource Use	Forestry activities, land use by the project, and increased road access changes the harvest potential for furbearer species

CASE STUDY
Determining if there are Cumulative Effects: Joint Panel for the Express Pipeline Proposal

To assist in its deliberations on cumulative effects during the public hearings for a proposed pipeline in Alberta (NEB 1996), the Review Panel identified three requirements that must be met before they would consider as relevant any evidence related to cumulative effects:

1. There must be an environmental effect of the project being assessed.
2. That environmental effect must be demonstrated to operate cumulatively with the environmental effects from other projects or activities.
3. It must be known that the other projects or activities have been, or will be, carried out are not hypothetical.

In the Panel's subsequent Decision Report (Priddle *et al.* 1996), the Panel noted that a further requirement was that the "cumulative environmental effect is likely to result".

2.2 AN OVERVIEW OF BASIC CONCEPTS

2.2.1 Effects Pathways

Cumulative effects occur as interactions between actions, between actions and the environment, and between components of the environment. These "pathways" between a cause (or source) and an effect are often the focus of an assessment of cumulative effects. The magnitude of the combined effects along a pathway can be equal to the sum of the individual effects (additive effect) or can be an increased effect (synergistic effect).[9]

CASE STUDY

Saskatchewan Uranium Mines: Pathways of Radionuclides

A study of the effects of various proposed uranium mine developments in northern Saskatchewan (➔ Appendix B) used pathways to define the various means by which radionuclides could disperse in the environment (Ecologistics 1992). Pathways were used to illustrate the linkages between a source (i.e., a mine), a dose on an environmental receptor (e.g., VECs such as moose, fish and benthic invertebrates), and the contribution of all pathways to a total dose on the environment. Generally, radionuclides could be dispersed in the atmosphere, groundwater or surface water. Dispersal may continue through vegetation and soils, forage crops, wildlife, aquatic plants and animals and sediment. An example of one pathway amongst these possible interactions is: Mine → Surface Water → Aquatic Plants → Total Dose.

2.2.2 How Cumulative Effects Occur

Cumulative effects can occur in various ways:

- **Physical-chemical transport**: a physical or chemical constituent is transported away from the action under review where it then interacts with another action (e.g., air emissions, waste water effluent, sediment).
- **Nibbling loss**: the gradual disturbance and loss of land and habitat (e.g., clearing of land for a new sub-division and roads into a forested area).[10]
- **Spatial and temporal crowding**: Cumulative effects can occur when too much is happening within too small an area and in too brief a period of time. A threshold may be exceeded and the environment may not be able to recover to pre-disturbance conditions. This can occur quickly or gradually over a long period of time before the effects become apparent. Spatial crowding results in an overlap of effects among actions (e.g., noise from a highway adjacent to an industrial site, confluence of stack emission plumes, close proximity of timber harvesting, wildlife habitat and recreational use in a park). Temporal crowding may occur if effects from different actions overlap or occur before the VEC has had time to recover.
- **Growth-inducing potential**: Each new action can induce further actions to occur. The effects of these "spin-off" actions (e.g., increased vehicle access into a previously unroaded hinterland area) may add to the cumulative effects already occurring in the vicinity of the proposed action, creating a "feedback" effect. Such actions may be considered as "reasonably-foreseeable actions" (➔ Section 3.2.4).

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[9] There are numerous other types of interactions defined in the literature by such terms as linear, multiplicative, compounding, structural surprise, space cycling, and space lags, etc. Although of interest in understanding the complexity of cumulative effects, determining which type is actually occurring (aside from additive effects) and measuring the interaction is often difficult in practice.

[10] This can include alienation of wildlife habitat due to sensory disturbances.

Can Project-Specific CEAs Adequately Address Regional "Nibbling" Effects?

Regional "nibbling" effects usually cannot be adequately dealt with on a project-by-project review basis. Although broad changes in a landscape can often be quantified (e.g., total cleared land, fragmentation of wildlife habitat), it is more difficult to determine a significance to this change that is only attributable to the specific action under review. To properly address this type of cumulative effect, regional plans are required that clearly establish regional thresholds of change against which the specific actions may be compared (➡ Section 4.2). Project applications can at least be compared to restrictions or requirements under any applicable land use plans or policies (e.g., Alberta's Integrated Resource Plans).

Careful Use of Terms

Ideally, cumulative effects should be assessed relative to a goal in which the effects are managed on a regional basis. Terms such as ecological carrying capacity, ecosystem integrity, long-term population viability and sustainable development are often cited as goals to be accomplished by CEAs. What these terms represent are important and their successful implementation would substantially improve the value of an assessment. They often appear in CEAs because they relate to relatively large landscape-level changes in a regional study area, and their broad application appears amenable to the objectives of future regional-based planning efforts.

However, expectations of what should be accomplished in CEA often exceed what is reasonably possible given our knowledge of natural ecosystems, available information, level of effort required to obtain more information, and the limits of analytical techniques in predicting the effects of actions on the environment. These terms should not be used in a CEA *unless* they are carefully defined; otherwise, the uncertainty associated with their meaning will later bring into question the usefulness of the CEA during its interpretation by regulatory reviewers.

2.2.3 Improvements in the Evolving Practice of CEA

The growing body of CEA literature, the increasing number of assessments completed, and direction from reviewing agencies and Boards (or Panels) has raised expectations of what should be accomplished in CEAs. Each assessment creates a precedent for what *can* and *should* be done. The following identifies some aspects of CEA that require improvement:

- Better identification of and focus on those project-specific effects with the greatest potential to act in a cumulative fashion with other actions.
- Application of regional coordinated land use planning and practical measures of limits to growth.
- Results that compare the incremental contribution of an action to regional thresholds for various VECs and indicate to what degree a threshold is approached or exceeded.
- Conclusions relying on more quantitative analysis.
- Broadening of the number of proven analytical approaches.
- Finer breakdown of more specific interactions among various actions.
- Ability to better examine synergistic effects, particularly the potential interactions between contaminant releases and direct physical effects and the influence these effects may have when combined with natural perturbations.
- The influence of environmental cumulative effects on socio-economic systems, as well as the effects of cumulative socio-economic changes on the regional environment.
- Selection of management options for dealing effectively with significant cumulative effects.

3.0 KEY TASKS IN COMPLETING CEAS

3.1 THE ASSESSMENT FRAMEWORK

CEAs build on what has been learned and applied in EIA practice for many years. However, assessment practitioners need to know in what ways assessing cumulative effects are different. This Chapter of the Guide identifies and discusses unique tasks in CEAs for each of the five steps in a basic EIA framework (from CEAA 1994): Scoping, Analysis, Mitigation, Significance and Follow-up[11]. This framework itemizes the typical steps followed by practitioners in completing EIAs. The information box below identifies each of the CEA tasks for these steps.

Frameworks

Assessment Framework

Basic EIA Steps	Tasks to complete for a CEA
1. Scoping	• Identify regional issues of concern • Select appropriate regional VECs • Identify spatial and temporal boundaries • Identify other actions that may affect the same VECs • Identify potential impacts due to actions and possible effects
2. Analysis of Effects	• Complete the collection of regional baseline data • Assess effects of proposed action on selected VECs • Assess effects of all selected actions on selected VECs
3. Identification of Mitigation	• Recommend mitigation measures
4. Evaluation of Significance	• Evaluate the significance of residual effects • Compare results against thresholds or land use objectives and trends
5. Follow-up	• Recommend regional monitoring and effect management

Ideally, all aspects of a CEA are done concurrently with the EIA, resulting in an assessment approach that makes no explicit distinction between the two "parts". In practice, however, the substantive work in a CEA is often done after the *initial* identification of effects have been completed in an EIA. In this way, the early identification of direct project effects "paves the way" for cumulative effects to be assessed. The Assessment Framework is suitable for assessing actions of any size. However, as discussed in Chapter 4, a scaled-down framework may be more suitable for assessing smaller actions (e.g., in screenings).

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[11] Mitigation may also be identified *after* significance is evaluated; however, the interpretation of significance changes (both approaches have been suggested in the EIA literature as valid). In the order shown in the Framework (mitigation before significance), significance reflects residual effects. This approach implies that mitigation must be identified regardless of whether there is a significant effect. However, this is not always an onerous task as many mitigation measures are "standard" practice and often expected to be recommended by regulators. In the reverse order (significance before mitigation), the significance reflects the "worst-case" situation before mitigation is applied, and therefore provides an understanding of what may happen if mitigation fails or is not as effective as predicted. In recent practice, the former approach is more common (mitigation before significance), largely to better reflect the eventual outcome to decision makers under the assumption that mitigation is effective as described.

During the completion of a CEA, the five steps of the framework are usually completed in order. However, earlier steps may be repeated during an assessment if new information suggests that earlier assumptions and conclusions were incorrect. Also, it is possible that the results of post-project effects monitoring may indicate that further assessment is required.[12]

What a Project-Specific Cumulative Effects Assessment Fundamentally Needs to Do

A CEA, for a single project under regulatory review, should fundamentally do the following:

1. Determine if the project will have an effect on a VEC.
2. If such an effect can be demonstrated, determine if the incremental effect acts cumulatively with the effects of other actions, either past, existing or future.
3. Determine if the effect of the project, in combination with the other effects, may cause a significant change now or in the future in the characteristics of the VEC after the application of mitigation for that project.

With the exception of the consideration of future actions, the above are identical to the requirements of a good EIA (the consideration of the effects of other actions is not necessarily new to CEA, as the existing environmental setting of a project has typically recognized other actions at least within the EIA's study area).

A key task in accomplishing the above is examining the effect on the VEC until the incremental contribution of all actions, and of the project alone to the total cumulative effect, is understood. Keep in mind that an assessment of a single project (which is what almost all assessments do) must determine if *that* project is incrementally responsible for adversely affecting a VEC beyond an acceptable point (by whatever definition). Therefore, although the total cumulative effect on a VEC due to many actions must be identified, the CEA must *also* make clear to what degree the project under review is alone contributing to that total effect. Regulatory reviewers may consider both of these contributions in their deliberation on the project application.

The remainder of this Chapter discusses in detail each step of the Assessment Framework (the page heading shows which step you are in).

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[12] Under CEAA, Responsible Authorities (RAs) do not have jurisdiction to conduct further assessments based on post-project monitoring.

3.2 STEP 1: SCOPING

Scoping (or focussing) involves the identification of key issues of concern and VECs, thereby ensuring that the assessment remains focussed and the analysis remains manageable and practical. This assists in determining if the action under review has the potential to contribute to any cumulative effects. Professional judgement is required to achieve an optimum balance between the minimum required by legislation and ideal goals. This is referred to as best professional practice.

Scoping is a well established first step in good EIA practice, and is essential in establishing the assessment's Terms of Reference. Although scoping is not unique to CEA, the larger regional nature and complexity of assessing cumulative effects means that scoping must be more strictly applied to avoid assessing more than is necessary. A first step in this direction is to focus only on those effects to which the action under review may actually by contributing. For example, although continued reductions in wildlife habitat may be a regional concern, there may be no reason to investigate these effects if the action under review does not contribute to these long-term reductions (e.g., a single pipeline may cause a slight and temporary loss of habitat for some species, while a network of seismic lines or logging roads may cause more significant long-term changes).

The scoping of regional cumulative (i.e., indirect) effects is often completed after the scoping of local (i.e., direct) effects in an EIA. In this case, information and conclusions from the EIA may assist in scoping of the CEA, including: action description, environmental baseline, identification of issues and VECs, types of effects caused, conclusions about significance of effects, and mitigation measures.

Although local effects may not have been scoped in the EIA in as large a scale as required in a CEA, the results provide a useful starting point.

What is Done First in Scoping?

The Assessment Framework identifies five tasks that must be done in scoping a CEA: issue identification, selection of VECs, setting of boundaries, identification of other actions and initial identification of potential impacts and effects. If performed in that order, the practitioner will be able to make decisions in one step that will guide the decisions for the next. However, this does not always have to be the case. In some situations (e.g., when very large areas have been digitally mapped by remote sensing), it may be more practical to first set some spatial boundaries, then identify other issues and actions, and finally select VECs.

In practice, elements of each of the five steps are often completed concurrently during the earliest stages of scoping. As scoping progresses, it quickly becomes clear what conclusions will be made.

3.2.1 Identify Regional Issues of Concern

While many of the issues addressed in an EIA will also be examined in a CEA, a CEA may assess a broader range of environmental concerns due to its larger study area. Issues should only be considered if their assessment will influence the decision regarding approval by the regulatory reviewers.

Issues can be identified by soliciting comment from local individuals and regional stakeholders, such as regulators, public organizations, industry, First Nations and directly affected parties. Issues can also be identified by specialists with scientific knowledge of the environmental effects.

Should a CEA Consider Contribution to Trans-Boundary and Global-Scale Effects?

Trans-boundary effects (e.g., animal migrations) and global-scale effects (e.g., atmospheric effects such as ozone depletion and global warming) must be addressed if a proposed action may contribute to such effects. However, in recognition of the complexities and often practical difficulty of scoping these effects, the CEA should at least identify the action's contributing causes, attempt to quantify the magnitude of the action's contribution, and suggest appropriate mitigation responses. In this way, decision-makers can account for the action's contribution within broad (i.e., national or international) initiatives.

It is therefore appropriate for a CEA to identify and assess trans-boundary or global-level effects that may be affecting the VECs under study; however, the level of mitigative response is often ultimately beyond the capability of a single proponent.

3.2.2 Select Appropriate Regional Valued Ecosystem Components

Valued Ecosystem Components (VECs) are components of the natural and human world that are considered valuable by participants in a public review process (Beanlands and Duinker 1983).[13] VECs need not be environmental in nature. Value may be attributed for economic, social, environmental, aesthetic or ethical reasons. VECs represent the investigative focal point of any EIA or CEA. CEA can be concerned with additive or synergistic effects on the same ecosystem components as would be considered in an EIA. In addition to this, CEA tends to be concerned with larger scale VECs such as within entire ecosystems, river basins or watersheds; and, broad social and economic VSCs such as quality of life and the provincial economy. VECs may also be used as indicators (➡ Section 3.3.2.3).

VECs can be selected by distilling stakeholder concerns, assessing and prioritizing various components through a weighting scheme, and soliciting input from workshops attended by experts and stakeholders (Hegmann and Yarranton 1995).

■ ***Valued Ecosystem Components***

CASE STUDY
Cold Lake Oil Sands Project: Issues, Valued Ecosystem Components and Indicators

Environmental Component	Regional Issues of Concern	Regional Valued Components	Examples of Indicators
Air Systems	Acidic deposition, odours, greenhouse gas emissions (global issue)	Air Quality	Emitted gases transported over long distances (NO_x, SO_2)
Surface Water	Lowering of lake water levels, contamination of water	Water Quality and Quantity	Combined water volume withdrawals, water quality constituents affecting drinking water standards

(cont . . .)

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[13] Practitioners use a considerable number of definitions and applications for VECs. It is beyond the scope of this Guide to discuss in detail this aspect of EIAs. The practitioner should examine some of the references provided to obtain a better understanding of VECs.

Groundwater	Depletion of aquifers	Potable well water	Combined water volume withdrawals
Aquatic Resources	Contamination of fish, increased harvest pressures	Sport fish species	Northern pike
Vegetation	Loss of vegetation through land clearing, effects of airborne deposition	Vegetation ecosites	Low bush cranberry, Aspen, White spruce
Wildlife	Loss, sensory alienation and fragmentation of habitat, direct mortality due to increased traffic and hunting harvest	Hunted and trapped species	Moose, black bear, lynx, fisher
Resource Use	Decreased opportunities for resource harvesting (fish, traditional plants, hunting, timber, trapping), increased road access, visual effects	Timber harvest areas, furbearers, game species, new road access, recreational enjoyment	Aspen stands, beaver, moose, campsites

3.2.3 Identify Spatial and Temporal Boundaries

Setting boundaries is the process of establishing limits to the area and period of time examined in an assessment. There are two types of boundaries: spatial (i.e., how far?), and temporal (i.e., how long into the past and into the future?). Spatial boundaries are often referred to as the "regional study area".

The challenge facing the CEA practitioner in establishing appropriate boundaries is in finding the balance between practical constraints of time, budget and available data, and the need to adequately address complex environmental interactions that, theoretically, could extend for considerable distances away and well into the future.

Setting Boundaries

3.2.3.1 Spatial Boundaries

EIAs have traditionally involved defining more or less arbitrary boundaries around action sites that are often local and limited to the effects of the single action. CEA, by definition, expands those spatial horizons. The practitioner must determine at what point to stop the pursuit of effects as some constraint on information gathering and analysis is necessary. Accurate and reliable determination of the probabilities of occurrence, and the magnitudes and durations of *all* potential effects would be costly, time consuming and excessive.

However, there remains the realities of the cause-effect relationships (known and perceived) caused by the action. The implication of too small a boundary is that important regional and long-term effects may not be examined. The long-range transport of pollutants in airsheds or waterways, the movements of far-ranging wildlife, and the progressive incursion of humans into hinterland areas are all examples that suggest the need to assess effects over a larger and larger geographic area.

The practitioner must determine at what point an effect is trivial or insignificant. The concept that such a point is reached at a certain threshold is attractive (➜ Section 3.5.3), but often difficult to define (especially quantitatively) except for cases in which regulated or recommended levels provide a point of comparison (e.g., for air and water emissions). The complexity of any relationship beyond those purely at the physical-chemical level often results in considerable reliance on best professional judgement and the consideration of risk. An adaptive approach should be followed when setting boundaries, in which the first boundary, often arrived at by an educated "guess", may later change if new information suggests that a different boundary is required.

An argument could be made in some cases that the boundary should be national, or even international. This scale of assessment is rarely merited and would usually be appropriate only for air or water effects (e.g., the long-range transport of air pollutants) or where species migrate over considerable distances. On a more pragmatic basis, boundaries can be assigned based on the limits of available data. A well-studied watershed, a well-known caribou migration path or available coverage of remote sensed imagery may influence the spatial extent of an assessment since the cost and time required to obtain more data may be prohibitive to the proponent and may not be justified by the needs of decision makers. The decision as to whether more data must be collected requires that the practitioners judge the adequacy of existing data in providing the basis for a sound and defensible assessment.

Ultimately, the assessment response should be appropriate to the project. Setting boundaries relies less on special CEA techniques than on the time-honoured basics of EIA practice of:

- making conservative assumptions about the magnitude and probability of the effect in the face of uncertainty (i.e., assume that effects will be greater rather than smaller);
- relying on professional judgement;
- practicing risk management; and
- using an adaptive approach.

Establishing Spatial Boundaries

Any of the following rules-of-thumb may be used to assist in setting spatial boundaries. It is important to understand that establishing boundaries is often an iterative process, in which a boundary may initially be identified without all the necessary information available, and subsequently modified if new information becomes available.

- Establish a local study area in which the obvious, easily understood and often mitigable effects will occur.
- Establish a regional study area that includes the areas where there could be possible interactions with other actions. Consider the interests of other stakeholders.
- Consider the use of several boundaries, one for each environmental component as this is often preferable to one boundary.
- For terrestrial VECs such as vegetation and wildlife, ensure boundaries are ecologically defensible wherever possible (e.g., winter range boundaries for assessing effects on critical wildlife habitat).
- Expand boundaries sufficiently to address the cause-effect relationships between actions and VECs.
- Characterize the abundance and distribution of VECs at a local, regional, or larger scale if necessary (e.g., for very rare species), and ensure that the boundaries take this into account.
- Determine if geographic constraints may limit cumulative effects within a relatively confined area near the action.
- Characterize the nature of pathways that describe the cause-effect relationships to establish a "line-of-inquiry" (e.g., effluent from a pulp mill to contaminants in a river to tainting of fish flesh and finally to human and wildlife consumption).
- Set boundaries at the point at which cumulative effects become insignificant.
- Be prepared to adjust the boundaries during the assessment process if new information suggests this is warranted, and defend any such changes.

Spatial Boundaries Should be Flexible

Practitioners often establish boundaries based on the "zone-of-influence" beyond which the effects of the action have diminished to an acceptable or trivial state (i.e., very low probability of occurrence or acceptably small magnitude). Ideally, such an approach should be taken for each effect on each environmental component examined (e.g., air, water, vegetation, wildlife), therefore requiring multiple boundaries instead of the more typical single study area. Bounds therefore become flexible, expanding and contracting according to the unique ecological relationships encountered. Using jurisdictional borders to define the study area may appear to be expedient, but such an approach usually ignores the ecological realities of the area.

For example, to determine boundaries for assessing water quality, one may "trace" the path of a chemical constituent along a river as far as one believes it may still be reactive and cause a significant effect. For wildlife with well-defined territories or ranges, one may "follow" the seasonal path of an individual and determine where it may be influenced by other actions, regardless of whether it crosses over national or international borders.

CASE STUDY
Examples of Establishing Boundaries

- Eagle Terrace, a 60 ha subdivision, was proposed on the slopes of a mountain valley in the Town of Canmore, Alberta (➡ Appendix B). In the assessment (Eagle Terrace 1996), boundaries were based on the availability of a vegetation base map that covered enough of a mountain valley to include a considerable number of actions adjacent to the project under review, and to adequately assess the effects on wildlife VECs in that valley.
- In the Cold Lake Expansion Project, boundaries were set for each environmental component (e.g., water, air) based on a combination of administrative boundaries and watershed features (such as rivers), resulting in a regional study area that included several other large actions (➡ Appendix B). The geographic boundaries for some VECs (wildlife, vegetation) were restricted to a township area due to the availability of historical and current information on vegetation composition and wildlife habitat (the extent of available air-photo coverage was also a factor in establishing boundaries). A judgement was made that the available information was sufficient to complete the assessment.
- A section of the Trans Canada Highway in Banff National Park was to be expanded from two to four lanes (➡ Appendix B). In the assessment (Parks Canada 1994), the smaller of two regional boundaries was based on the constraining topography (i.e., mountain valleys) and their implications to watersheds and physical barriers to wildlife movements. The larger boundary was based partly on administrative borders.

3.2.3.2 Temporal Boundaries

"How far back in time" and "how far ahead in the future" to consider in an assessment depends on what the assessment is trying to accomplish. Comparison of incremental changes over time requires the use of historical records for establishing an environmental baseline. The possibility of new actions requires the need to look ahead into the future.

The boundary in the past *ideally* begins before the effects associated with the action under review and possibly before the effects of most major actions were present. The boundary in the future typically ends when pre-action conditions become re-established (i.e., VECs have recovered and effects become trivial). However, the further back or ahead in time, the greater the dependence will be on qualitative analysis and conclusions due to lack of descriptive information (e.g., what conditions were like years ago or which other actions may occur in the future) and increasing uncertainty in predictions. For these reasons, in practice the scenario in the past often defaults to the year in which the baseline information for the assessment is collected (i.e., current conditions) and the future extends no further than including known (i.e., certain) actions.

The use of scenarios provides a useful approach to determining temporal boundaries. Scenarios represent a point in time with specific disturbances and environmental conditions. Incremental changes between scenarios can then be compared to assess the relative contribution of various actions to overall cumulative effects within the regional study area.

In practice, temporal boundaries often first reflect the operational life or phases of the action under review (e.g., exploration, construction, operations, abandonment),[14] and then extend to reflect the life of all actions under progressively greater levels of regional development. In either case, the scenarios are often associated with a single year or range of years (e.g., 1997-2000).

Establishing Temporal Boundaries

In general:

- Organize time-dependent changes in discrete units of time (e.g., as sequential time scenarios).
- Be prepared to adjust the boundaries during the assessment process, and defend any such changes.

The following provides some options for establishing temporal boundaries. In some assessments, more than one temporal boundary may be necessary (e.g., for actions with sequential operational and abandonment phases for different components of the action).

Options for establishing the past boundary

Each of the following options progresses further back in time:

- when impacts associated with the proposed action first occurred;
- existing conditions;
- the time at which a certain land use designation was made (e.g., lease of crown land for the action, establishment of a park);
- the point in time at which effects similar to those of concern first occurred; or
- a past point in time representative of desired regional land use conditions or pre-disturbance conditions (i.e., the "historical baseline"), especially if the assessment includes determining to what degree later actions have affected the environment.

Options for establishing the future boundary

Each of the following options progresses further ahead in time:

- end of operational life of a project;
- after project abandonment and reclamation; or
- after recovery of VECs to pre-disturbance conditions (this should also consider the variability of natural cycles of change in ecosystems).

Each option progressively better reflects the true effects of the action; however, assessment becomes more difficult to quantify if the time periods are very long (e.g., >30-50 years).

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[14] Accidental (or "upset" or emergency) events may occur. These events are rare but of significant magnitude. It is suggested that these events be assessed as unique scenarios, as their effects are too extreme to be assessed with those caused by normal operational activities.

CASE STUDY
Eagle Terrace Sub-division: Temporal Scenarios

Four scenarios were developed for the Eagle Terrace CEA (Eagle Terrace 1996) to assess the incremental changes caused by developments in a mountain valley:

1. ***Pristine***: conditions prior to any or extensive human development, which was simulated by removing the footprint of all developments from a Geographic Information System (GIS) database
2. ***Current***: existing conditions
3. ***Future without action***: future conditions that are predicted to occur, but without the action under review
4. ***Future with action***: future conditions that are predicted to occur with the action under review

CASE STUDY
Natural Gas Field Development: Regional Development Scenarios

In 1992, the British Columbia government requested a cumulative effects study (Antoniuk 1994) in the 5000 km^2 Monkman/Grizzly Valley gas development area in northeastern British Columbia on the Rocky Mountain Eastern Slopes. This was in response to an increase in gas exploration and development in the region, and particularly an application for a gas plant expansion by Westcoast Energy which would induce other projects to occur. Seven companies, all active in the area and who would use the plant, collaborated in supporting an evaluation of the effects of gas exploration and development over a 15-year period between 1983 and 1998, including additional production from five new facilities.

The assessment, termed an Environmental Protection Strategy, used a regional development scenario to "identify the scale of development likely to occur in the near to medium term" so that "conclusions could be used to establish disturbance thresholds, delineate sensitive areas for key resources, and ensure that mitigation, monitoring and research are focussed on significant environmental issues".

A Regional Development Scenario was used in lieu of specific exploration and production plans from 1993 to 1998. This included determining quantitative limits or thresholds for various indicators during three scenarios: existing, minimum and maximum development. Thresholds were determined for the following: kilometres of seismic lines; kilometres of roads; kilometres of pipelines; number of dehydrating plants; and number of wells.

CASE STUDY
Oil and Gas Developments in Alberta's Eastern Slopes: Consideration of Full Project Build-out

The Alberta Energy and Utilities Board is the provincial regulatory authority responsible for the review of a variety of industrial, power, and oil and gas projects. The Board issued assessment Guidelines for proponents of projects in the environmentally sensitive Eastern Slopes region of Alberta's Rocky Mountain front ranges south of the Bow River (ERCB 1993). Included in these Guidelines is the request for proponents, for each project stage, to "estimate the overall extent of development" to "avoid piecemeal proposals" and "consolidate their plans and activities with other operators to the greatest degree practical wherever this may reduce area impacts". To assist in accomplishing this, applications for licenses for single projects (e.g., wells) are to be submitted as "development plans rather than on a piece-meal or single-well approach". Development plans are particularly important for areas that are relatively undeveloped or "minimally-developed".

Development plans would begin at the earliest stages of exploration, even though future plans at that time were very uncertain. Future project components would include associated infrastructure and expansions (e.g., pipelines, access roads, and processing plants) that would proceed if exploration led to commercial operations. The level of detail would vary according to the phase and sensitivity of the area (generally, the less the existing intrusions such as access roads, the more sensitive the area).

3.2.4 Identify Other Actions

All actions need to be identified that have caused or may cause effects and may interact with effects caused by the action under review.

Identifying Other Actions

1. Within the Regional Study Area(s), identify candidate actions that meet the *Action Selection Criteria* (➧ Section 3.2.4.1).
2. Characterize the actions according to the *Action Description Criteria* (➧ Section 3.2.4.2).
3. Clearly identify (e.g., list) each action being considered.
4. Modify the Regional Study Area(s) to accommodate the final list of actions, if required.

3.2.4.1 Action Selection Criteria

In recognition of spatial and temporal boundaries (➧ Section 3.2.3), identify actions associated with the project that meet the criteria shown in Table 1.[15]

Table 1: Spatial and Temporal Criteria for Selection of Actions

Spatial criteria	Temporal criteria
• Actions with footprints within the regional study area(s) that may affect the VECs being assessed. Footprints include associated components (e.g., access roads, powerlines), and include air or areas of land or water directly disturbed. • Actions outside the regional study area if it is likely that any of their components may interact with other actions or VECs within that area.	• **Past**: actions that are abandoned but still may cause effects of concern. • **Existing**: currently active actions. • **Future**: actions that may yet occur.

Past Actions

Past actions are no longer active yet continue to represent a disturbance to VECs (e.g., ongoing effects of an abandoned gravel pit on terrain, or a plume of solvents from an abandoned wood preserving factory on a nearby aquifer). It is possible that the effects may no longer be readily observable (e.g., review of maps or airphotos shows little evidence of the action). However, significant changes may remain to ecological processes and VECs. In practice, past actions often become part of the existing baseline conditions. It is important, however, to ensure that the effects of these actions are recognized.

Future Actions

Selection of future actions must consider the certainty of whether the action will actually proceed. Figure 1 lists criteria that may be used in the selection process. The figure categorizes actions into three types:

- ***Certain***: The action will proceed or there is a high probability the action will proceed.

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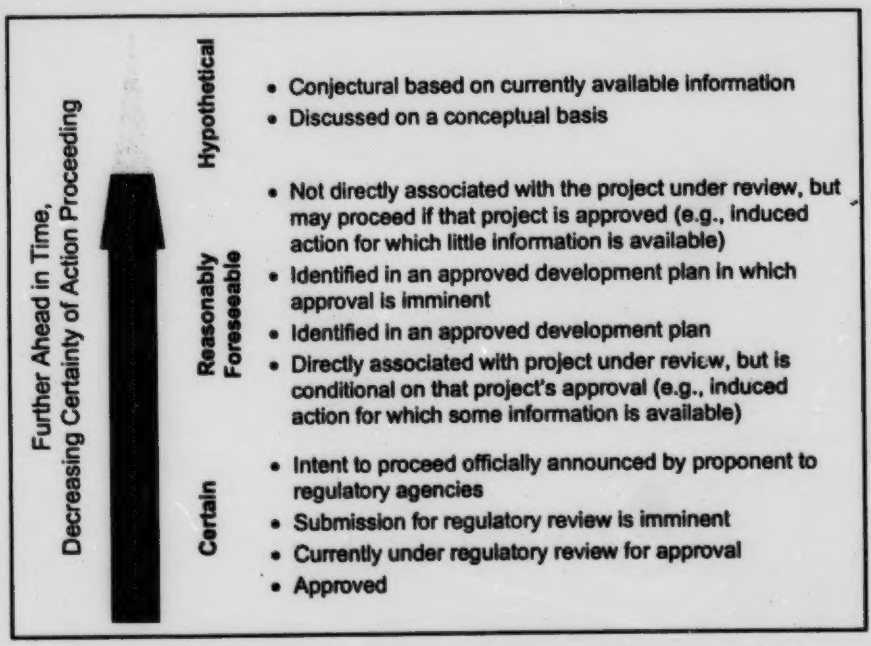
[15] It is often suggested that certain natural events, such as flooding and forest fires, be considered as an action in the same context as human-caused events. This Guide suggests that such natural events should be considered as one of the attributes that describes environmental baseline conditions.

- ***Reasonably Foreseeable***: The action may proceed, but there is some uncertainty about this conclusion (The Canadian Environmental Assessment Agency's Operational Policy Statement *Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act* recommends that at least these types of projects be considered).
- ***Hypothetical***: There is considerable uncertainty whether the action will ever proceed.

The selection of future actions to consider should at least reflect the certain scenario and at best the most likely future scenario. Rigid adherence to minimum regulatory requirement however is increasingly becoming unacceptable to many stakeholders if there is reason to believe that at least some reasonably foreseeable projects could have a significant cumulative effect with the project under review (also, precedent setting court and panel decisions on project approvals will continue the evolution of change regarding what is and is not expected and acceptable practice). Practitioners are therefore encouraged to consider the opportunity to also include reasonably foreseeable actions. The final decision for the assessment is often at the practitioner's discretion or under the direction of the regulatory authority.

Figure 1: Options for Selecting Future Actions

As one proceeds upwards along the arrow, the certainty decreases of the action occurring.



- Conjectural based on currently available information
- Discussed on a conceptual basis

- Not directly associated with the project under review, but may proceed if that project is approved (e.g., induced action for which little information is available)
- Identified in an approved development plan in which approval is imminent
- Identified in an approved development plan
- Directly associated with project under review, but is conditional on that project's approval (e.g., induced action for which some information is available)

- Intent to proceed officially announced by proponent to regulatory agencies
- Submission for regulatory review is imminent
- Currently under regulatory review for approval
- Approved

The actions in Figure 1 lie on a continuum from most likely to least likely to occur. The practitioner will have to decide how far the proponent is obligated to go by statutory requirement, and by this obligation to demonstrate best practice. In the latter case, the reason for proceeding beyond statutory requirement (if defined) is to ensure that important future developments that may cause significant cumulative effects with the action under assessment have been adequately addressed. The practitioner will have to decide whether consideration of these future actions will be important to regulatory reviewers of the action. Furthermore, various regulatory agencies, due to their unique responsibilities, may modify or expand on what constitutes actions to be included.[16]

Although requiring interpretation on a case-by-case basis, the selection of future actions will be a compromise between under-representing the full extent of future change and identifying and assessing an unreasonably large number of actions. As with most matters facing practitioners, compromises are continually made between the minimum required by legislation and the professional obligations perceived by the practitioner.

A major criterion for selecting other actions is whether the action causes similar effects on the same VECs as the action under assessment. Focussing on actions with similar effects is a good first step, and will ensure that the most appropriate actions are included in the assessment (i.e., those with the greatest likelihood of causing effects that interact). Such a criterion is attractive from a practical point of view, as it could significantly reduce the number of actions a practitioner may have to consider.

However, cumulative effects also occur solely due to the physical presence of an action as it occupies space in the landscape and contributes indirectly to other activities (such as road traffic). The presence of an action always leads to some degree of landscape fragmentation, representing a "nibbling" loss of land potential to support other uses (it is this type of cumulative effect that cannot always be easily addressed on a project-by-project review basis).

The criterion of similar effects may be too restrictive if such effects are interpreted only as a physical or chemical interaction between the actions. For example, if a pulp mill is the action under review and the major effluent is waste discharge into a river, then the only other actions selected on this basis would be other sources of effluent if the *major* issue of concern was water quality in the river. However, other types of actions may *also* contribute to air emissions, land clearing and sedimentation in waterways.

Induced Actions

Induced actions are projects and activities that may occur if the action under assessment is approved. Induced actions may not be officially announced or be part of any official plan. They usually have no direct relationship with the action under assessment, and represent the growth-inducing potential of an action. New roads leading from those constructed for a project, increased recreational activities (e.g., hunting, fishing), and construction of new service facilities are examples of induced actions. Increases in workforce and nearby communities contribute to this effect.

There may always be the potential for induced actions following any action. However, a practitioner usually can only conjecture as to what they may be, their extent and environmental implications. Must the practitioner nonetheless always consider the implications of induced actions?[17]

Induced actions (e.g., public activities) rarely fall under the scrutiny of an approved process: they just happen, and one must examine the likelihood of this based on existing use, precedent and implications of the assessed action proceeding. Best practice suggests that effort should be made in identifying actions if there is reason to believe they may occur, yet are not overly hypothetical.

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[16] For example, the Alberta Energy and Utilities Board considers the following as candidates for actions that will occur in the oil and gas industry: field study is underway, land base is leased, or resource delineation is favourable to future production.

[17] This argument has especially been made in cases where no other specific future actions can be identified (e.g., in remote hinterland areas). When combined with highly successful mitigation measures, proponents may confidently claim that there are no cumulative effects. However, induced actions may represent the only source of important cumulative effects.

As illustrated in Figure 1, consideration of induced actions may be more reasonable if there is sufficient information describing them to allow an adequate assessment of their effects.

Ultimately, because of the uncertainty and often dispersed nature of these actions (i.e., they may occur in many places within a region), induced actions are best considered as part of Regional Land Use Planning Studies involving regional administrative agencies.

Example Action List

The following is an example of the type of actions that may be considered for an action proposed in a forested area under "multiple-use" conditions.

Resource Extraction

Hunting/Fishing
Mining
Oil and gas exploration
Oil and gas wells
Pipelines
Processing plants
Quarries
Saw mills
Seismic lines
Timber harvesting
Trapping

Recreational Use

Camping
Equestrian use
Fishing
Hunting
Mountain biking
Nature tours
Off-highway vehicle use
Outfitting
Wildlife viewing

Land Use and Infrastructure

Access roads
Highways
Protected areas
Railways
Residential communities
First Nation's Traditional Land Use
Agriculture

3.2.4.2 Action Description Criteria

Each action that meets the selection criteria must be described in adequate detail to allow effects to be characterized for later assessment. As a general rule, the amount of information that can be obtained is usually proportionate to the degree of certainty of the action proceeding.

Some actions may have to be assessed generically because there are too many to practically characterize individually. This may be the case if there are many small actions suspected of causing minimal effects due to short duration, low magnitude, irregular and unpredictable occurrences, or temporary duration. If there are numerous actions, it helps if they are organized by some categories in recognition of the similar types of effects they may cause. For example, they can be organized by:

- shape (e.g., linear, areal dispersed, areal point);
- sectoral type (e.g., resource extraction, power generation, urban infrastructure);
- industry type (e.g., mining, forestry, municipal infrastructure); or
- transportation type (e.g., aircraft, boats, road traffic).

The most important information to obtain about other actions is that which will assist in identifying and assessing effects on the same VECs as being assessed for the action under review. These effects can at first be broadly categorized by major environmental components, such as air, water, soils, vegetation, wildlife and resource use.

Some or all of the following information may be required to adequately assess an action's contributing effects:

- location, physical size (e.g., area covered, volume of process throughput) and spatial distribution of components (e.g., site specific, randomly dispersed, travel corridors);

- components (e.g., main plant, access roads, waste disposal site) and supporting infrastructure (e.g., waste treatment, powerlines);
- expected life or period of activity (including start date) and phasing involved (e.g., exploration, construction, standard operations, later plans for upgraded or expanded operations, decommissioning and abandonment);
- variations in seasonal operation (e.g., winter closures);
- number of permanent and temporary employees;
- frequency of use (for intermittent activities, e.g., helicopter use);
- transportation routes and mode of transport (e.g., roads, railways, shipping lanes);
- processes used (for industrial activity, e.g., open pit mining, kraft bleaching); and
- approvals received (e.g., permit and license conditions in effect).

Information sources for actions can include:

- site visits or tours;
- land use maps and aerial photos;
- environmental databases, land use planning registers;
- interviews and consultation with emissions control regulators, residents, businesses, administrative authorities, etc.;
- development plans (e.g., catchment management plans, air quality management plans); and
- other EIAs and State of the Environment Reports.

What If Information about an Action Is Not Available?

Information about another action may not be readily available if:

- proprietary process technology or confidential production records are involved (e.g., for resource-based industries);
- for projects approved or under construction, the project design is too preliminary to provide enough useful information; or
- for reasonably foreseeable actions, the action is only identifiable by name but little else is known.

In such cases, the assessment must rely on publically available information (e.g., municipal plans) as much as possible. Any limitations this places on the assessment must be clearly stated. If no or little information is available, it is difficult to predict cumulative effects unless the practitioner assumes certain project attributes (e.g., content of waste discharge). These assumptions should be clearly stated, and the uncertainty this causes in the assessment should be explained.

A reasonable attempt to collect information must at least be demonstrated. Lack of usable information about other actions can have important implications to the certainty associated with predictions made in a CEA.

CASE STUDY
Placer Mines in the Yukon: Grouping Project Types

Placer (i.e., in-stream) mining for gold has a long history in the Yukon. Some streams have been extensively mined, in some cases repeatedly by different proponents in the same location over many years. It is not unusual for many placer claims and operational mines (e.g., greater than 10) to exist along the same waterway.

In assessing a project located in or near one of these streams, identifying each placer mine and its cumulative effects with the project under review may be unnecessary. In this case, all the placer mines of similar physical and production size could be grouped to represent downstream and upstream effects on the waterway.

3.2.5 Identify Potential Impacts

Potential impacts must be identified that may affect the VECs. This scoping step is important as it assists the practitioner in beginning to understand one of the most fundamental assessment questions: what is affecting what? Good scoping in the initial stages of the study will mean that the assessment effort will focus on the most likely effect's pathways of concern.

One approach to accomplishing this, a common step in may EIAs, is to first identify environmental components (e.g., air, water) that may be affected by various project components (e.g., land clearing, combustion emissions) for the project being assessed. Then, environmental components that may be affected by other actions in the region of interest can be identified. The scoping could then proceed to focus on the relationships between specific impacts from various actions and specific VECs. The next section describes one means of practically accomplishing this.

3.2.5.1 Using Interaction Matrices

An Interaction Matrix is a tabulation of the relationship between two quantities. Matrices are often used to identify the likelihood of whether an action may effect a certain environmental component or to present the ranking of various effect attributes (e.g., duration, magnitude) for various VECs. Matrices are an example of one tool that can be used during scoping exercises to identify the potentially "strongest" cause-effect relationships, and later to concisely summarize the results of an assessment.

Matrices, however, only show the conclusions made about interactions, and cannot themselves reveal the underlying assumptions, data and calculations that led to the result shown; matrices are a simplistic representation of complex relationships. Matrices should, therefore, be accompanied by a detailed explanation as to how the interactions and rankings were derived (e.g., in a "decision record").

A CEA can also use a matrix to rank the "strength" of the interaction between each action in the regional study area and regional VECs (i.e., how strong is the effect on a VEC due to the overlap of effects from two different actions?). The interactions can be qualitatively ranked (e.g., 1 = low to 5 = high on a 5-point scale), or use a number that represents a physical quantity. The first type of ranking is currently the more commonly used in assessments.

It may also be necessary to return and examine relationships ranked negligible or low if later information suggests they may be more important, or if the public has considerable interest in the issue.

Ranking Mechanisms for Matrices

The following two tables provide *examples* of using matrices to rank effects (IORL 1996a and DIAND 1997, respectively). Such simple rating schemes are often used during early scoping exercises, before more detailed assessment confirms the validity of conclusions reached in the matrix.

Ranking of Effects Based on Effect's Attributes

A ranking of L (Low), M (Moderate), or H (High) is determined based on the duration, magnitude and extent of an effect.

Duration	and	Magnitude	Extent			
			Local	Regional	Territorial	National/ International
Short-term	and	Low	L	L	M	M
Short-term	and	Moderate or High	L	M	M	M
Medium-term	and	Low	M	M	M	M
Medium-term	and	Moderate or High	M	M	M	H
Long-term	and	Low	M	M	H	H
Long-term	and	Moderate or High	M	H	H	H

Ranking of Effects Based on Spatial and Temporal Overlap

Temporal Overlap	Spatial Overlap of Effects		
	None	Partial	Complete
Never/Rarely	L	M	M
Sometimes	L	M	H
Often	L	H	H

CASE STUDY
Cold Lake Oil Sands Project: Interaction Matrix for Various Project Components

An Interaction Matrix was used during an early scoping workshop for the Cold Lake Oil Sands Project (IORL 1997a) to begin to identify possible relationships between various project actions and environmental components. This was done for all project phases (preliminary activities or exploration, construction, operations and abandonment). The following matrix shows the results for the operations phase. The ranking system is based on a combination of potential duration, magnitude and extent of the interaction (the higher the number, the greater the strength of the relationship; interactions with numbers above 2 were considered important enough for more detailed assessment).

	Environmental Components															
Project Activity	Landforms/Terrain	Soils	Hydrogeology/Geology	Surface Water Quantity	Surface Water Quality	Fish	Invertebrate Fauna	Aquatic Vegetation	Air Systems	Terrestrial Vegetation/Wetlands	Amphibians	Terrestrial/Semi-aquatic Wildlife	Rare/Endangered Species	Aboriginal Land Use	Recreational Land Use	Commercial Land Use
Well Servicing	0	0	3	0	0	1	1	1	0	0	0	3	3	1	1	1
Co-generation	0	0	0	0	0	1	1	1	3	0	0	3	3	1	1	1
Steam Injection	0	0	0	3	1	1	1	1	0	0	0	3	3	1	1	1
Bitumen Production	0	0	1	0	0	1	1	1	2	0	0	3	3	1	1	1
Makheses Plant	0	4	0	3	1	1	1	1	4	4	0	3	3	1	1	1
Deep Well Disposal	0	0	4	0	0	1	1	1	0	0	0	0	0	0	0	0
Water Use	0	0	4	4	0	1	1	1	0	0	0	0	0	1	1	1
Ancilliary Facilities	0	3	4	3	1	1	1	1	1	0	3+	3	3	2	2	2
Access/Transportation	0	2	2	3	1	4	3	4	1	3	2	4	4	3	3	3
Workforce	0	0	0	0	0	4	1	1	0	0	0	4	4	2	2	2
Pipelines	0	0	0	0	0	1	1	1	0	3	0	3	3	3	3	3
Upset Events	2	4	5	?	5	5	5	5	4	3	4	3	4	4	4	4

CASE STUDY
Trans Canada Highway: Interaction Matrix for Various Actions

In a CEA of the Trans Canada Highway (Parks Canada 1994), the potential degrees of interaction between various regional actions and environmental components was determined. Sixteen actions were identified and the effects of each action on 10 environmental and social components were ranked from negligible to high. Below is a sample of the matrix used to present the results.

Project	Terrain	Air Quality	Vegetation	Fish	Visual
Existing highway	M	L	L	H	L
Powerline	-	-	L	-	L
Railway	M	L	L	M	L
Townsite	L	-	L	-	L

- = Negligible, L = Low, M = Moderate and H = High

CASE STUDY
Kluane National Park: Effect's Interaction Matrix

An assessment of the effects of various existing and proposed actions in and around Kluane National Park Reserve was conducted (Hegmann 1995) that included the effects on key wildlife VECs. The following effect's scoping matrix shows some of the results for grizzly bear. Six types of effects were identified as well as an overall effect that served to represent the combined influences of all effects from each action on the VEC.

	Effects						
	Habitat Loss	Fragmentation	Alienation	Obstruction	Mortality	Removals	Overall
Existing Actions							
Backcountry camping	L		M	L	H	H	M
Backcountry hiking			M		M	M	M
Flightseeing			H				H
Aircraft tripping support/ Lowell Lake			H				H
Rafting campsites	L		M		H	H	H
Snowmobiling			L				M
Horseback riding			M		M	M	M
Mountain Biking			L		M	M	M
Hunting: aboriginal subsistence					H		M
Future Actions							
Alsek Pass/Sugden Creek Road	M	M	H	M	M	M	H
Slims Valley Roads/Day Use	L	M	H	M	H	H	H
Sheep Mtn. Sheep Interpretation							
Mush Lake Road/Day Use	L	L	M	L	M	M	M
Goathead Mtn. Trail			L		M	M	M
Slims Valley Trails			M	M	H	H	H
Shuttle to Bear Camp			H		M	M	M
Shuttle to Lowell Lake (Jetboat, hovercraft)			H				H
Helihiking			H				H

The rankings are defined as: "blank"=no effect; L=low probability of occurrence or magnitude of effect (on reproductive capacity of species or productive capacity of habitat) probably acceptable; M=moderate or possibly significant effect; H=high probability of occurrence or magnitude of effect probably unacceptable (e.g., population recovery may never occur or may occur in the long-term). A ranking option for positive effect (+) was also provided.

3.3 STEP 2: ANALYSIS OF EFFECTS

3.3.1 Collect Regional Baseline Data

A common concern of proponents is the level of effort and resources (i.e., time and money) required to collect adequate data to assess regional cumulative effects. While early scoping is required to ensure that the assessment is focussed on the most important VECs, it also ensures that data collection is limited to only that required to address these issues. In some cases, the collection of data for some environmental components, such as water quality, air quality and noise levels, provides baseline data that often captures the collective effects of existing actions.

CEA practitioners must have a clear understanding of how the data will be used in support of a clearly defined and scientifically defensible analysis. As a rule-of-thumb, it is not advisable to embark on costly data collection and analysis without careful consideration of the results it may yield. Practitioners have to often adopt a "coarse filter" approach to data collection; that is, the level of information is not as detailed as in an EIA because of the much larger area covered (also, the *type* of data required may change as the scale of the assessment changes). For example, soils and vegetation field studies may be relatively intensive within the proposed project footprint and involve on-site mapping. However, for regional study areas of thousands of hectares, analysis may have to be based on satellite imagery or existing vegetation surveys completed at very broad scales.

Who has the Most Information to Collect?

A substantial amount of biophysical data will be required to conduct an EIA for the first action proposed within a relatively undisturbed hinterland area. However, in most cases, such data are not already available. Subsequent project assessments will then benefit from the data and analysis done. This benefit will increase if raw field data are subsequently made available to proponents of future actions.

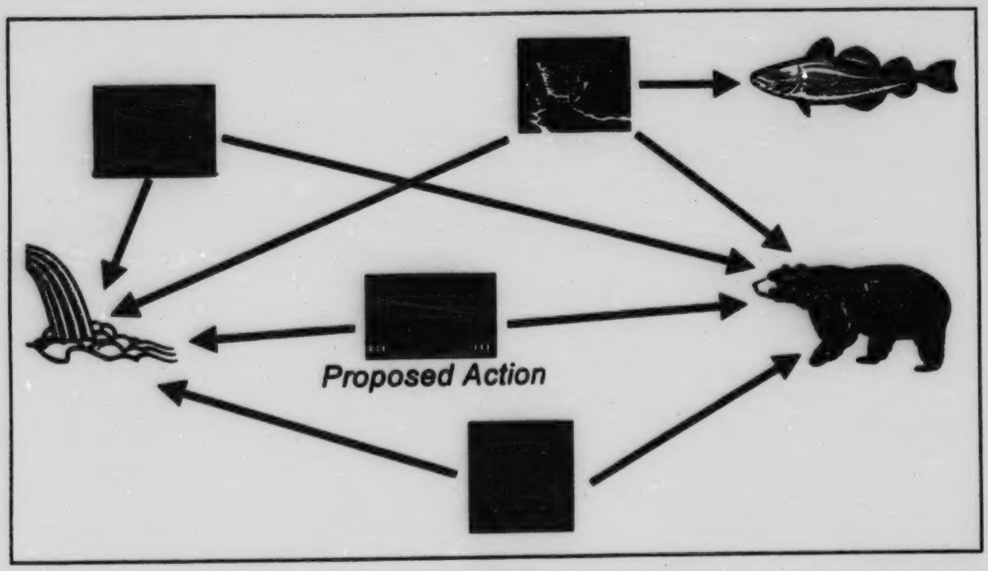
However, a CEA for that first action may require little data collection, as there are few if any other actions in the region (except, possibly, induced actions which are likely and for which adequate descriptive information exists). Each successive CEA for subsequent actions in the vicinity of the first action will then require more data collection to characterize the increasing number of other actions in that region. A benefit to decision-makers is that more information becomes available to use in their decision making about subsequent actions (a tiering of project applications).

3.3.2 Assess Effects on VECs

The analysis of cumulative effects should focus on assessing effects on selected VECs (➜ Figure 2). Several approaches are available to assist the practitioner in assessing cumulative effects. However, there is no one single approach to always be used, nor necessarily one type of approach for specific effects or types of actions. Instead, the practitioner must select an appropriate approach or assessment "tool" from a collection or "toolbox" of approaches. The appropriate method is the one that best provides an assessment of the effects on the VECs being examined.

Figure 2: Focussing on Effects on VECs

The CEA should be looked at "from the VECs point of view", in which the combined (i.e., cumulative) effects of the various actions on each VEC (i.e., bear and water quality) are assessed (arrows indicate an action causing an effect on a VEC). Furthermore, although the fish is affected by one of the other actions, it should not be considered because it is not affected by the proposed action under review (unless the bear eats the fish!).



Of the many tools available, a few have been repeatably used in EIAs, and more recently, in CEAs. These are listed in Table 2 and described in more detail afterwards. The practitioner is also encouraged to review some of the literature cited in this Guide (➔ Appendix D) for more details about these and other tools.

Analytical Approaches

Table 2: Examples of Assessment Tools and their Appropriate Use

Tool	Examples of Appropriate Use
Impact Models	Detailed assessment of cause-effect relationships between an action and VECs
Spatial Analysis using a Geographic Information System	Quantifying physical properties of actions (e.g., length of roads, area of cleared land) and changes to landscape features (e.g., loss of wildlife habitat)
Landscape Level Indicators of Change	Providing numerical values that represent large-scale disturbances or change
Numerical Modelling	Quantifying physical-chemical constituents (e.g., air and water quality)

Many tools are narrowly focussed and are case specific. Some provide qualitative evaluations that assist in scoping an action's effects, while others provide a more quantitative (i.e., numerically based) analysis. Selection of the most appropriate tools can be based on consideration of the following:

- ability to organize, analyze and present information;
- stage of the assessment (e.g., scoping, baseline data collection, analysis);
- types of issues;
- types of disturbances and effects;
- types of VECs;
- quality and extent of baseline data;
- level of expertise available; and
- resources available to complete an acceptable assessment to meet the needs of decision makers.

If possible, practitioners should predict future conditions that may exist in their reasonably foreseeable scenarios. However, if uncertainties remain concerning details about future actions or about complex interactions, the practitioner may wish to discuss future *trends* instead. For example, one could pose a theoretical question, such as "If population growth continues at the historical rate and there is no change in wastewater treatment, then it is probable that...". The conclusion would be based on the best scientific data and most advanced analysis possible, but leaving the final interpretation to the professional judgement of the practitioners and, ultimately, to the regulatory reviewers.

Questions to Ask When Assessing Effects

- What are the VECs that may be affected?
- What parameters are best used to measure the effects on the VECs?
- What determines their present condition?
- How will the proposed action in combination with existing and approved actions affect their condition?
- What are the probabilities of occurrence, probable magnitudes and probable durations of such effects?
- How much further effect could VECs sustain before changes in condition can not be reversed?
- What degree of certainty can be attached to the estimates of occurrence and magnitudes of these predicted effects?

(Hegmann and Yarranton 1995)

Assessing Individual Interactions: Hydroelectric Projects in a Watershed

In practice, CEAs do not usually assess individual interactions between every action and all VECs. Instead, the current state-of-the-art is to assess the overall interaction between the one action under review with *all* other actions in the regional study area that may also affect a specific VEC (e.g., as accomplished with a GIS). Assessing one particular interaction may only be necessary if it involves a single effect of major concern or if it is known that the interaction is more complex than just additive (e.g., the synergistic effect on fish that may occur during the interaction between two different chemical compounds discharged into the same river from two pulp mills).[18]

This reflects the difficulty in meaningfully characterizing the numerous individual interactions among actions, particularly for biological organisms. In some cases, because of very important and unique relationships, interactions between each action may have to be identified. Few techniques have proven effective at this.

One method, referred to as the Multiple Human Development Model (Bain *et al.* 1986), has attempted to accomplish this. This approach, developed to examine the cumulative effects of several dams within the same watershed, is based on two concepts:

1. The relationship between an action's disturbance and its effect on a VEC can be defined as a mathematical function (e.g., as the magnitude of the impact of land clearing increases, the effect on nesting eagles also increases in a linear fashion).
2. The total interaction between any two actions is calculated as the sum of the local effects of each action and the effects of each action on the other, where the final arithmetic total effect is assigned a numerical value.

The numerical values in concept (2), referred to as "interaction coefficients", are then entered into a matrix (action-versus-action), and algebraically reduced to one number representing the overall cumulative effect of dams in the watershed. However, these coefficients are only subjectively determined by professional judgement.

As to whether this approach will be widely adopted depends on the level of certainty placed on the analysis and how successfully decision-makers can meaningfully interpret the one number that represents the final matrix conclusion (e.g., the overall average cumulative effect of a proposed hydro dam is 3.2 on a scale of 0 to 5).

Checking for Spatial and Temporal Overlap

The concept of the physical overlapping of effects leading to cumulative effects can be a useful approach to understanding the nature of the interactions. The following series of questions could be used in determining the degree of overlap between actions (Hegmann 1995):

1. Do actions rarely or never occur at the same time, and do actions originating in one location rarely or never continue on to other locations? If yes, cumulative effects interaction is weak.
2. Do actions in each location sometimes occur at the same time, and do actions originating in one location sometimes continue on to other locations? If yes, interaction is moderate.
3. Do actions in each location often occur at the same time, and do actions originating in one location often continue on to other locations? If yes, interaction is strong.

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[18] As a region becomes more heavily disturbed due to many actions, it may become difficult to determine which project is responsible, and to what degree, for which effects (a classic example is the United Kingdom with a legacy of hundreds of years of development). For regions with significant wilderness areas and lower development intensity, identifying the action responsible for specific effects may be more clear.

3.3.2.1 Impact Models

Impact Models have been used extensively in EIAs, and may be adopted as a CEA approach because they provide a concise description of cause-effect relationships that occur between an action and the surrounding environment.[19] The Impact Model approach involves testing the validity of a statement, similar to that made in a scientific hypothesis. The advantage of using Impact Models is that they provide a simplification of complex systems, allowing a step-by-step analysis of each interaction in a cause-effect relationship. They also facilitate the description of cause-effect relationships over large areas.

Impact Models have three parts (➧ *Cold Lake Oil Sands Project: Applying Impact Models* for an example): Impact Statement, Pathways Diagram and Linkage Statements. The assessment of the model involves two steps: Linkage Validation, and Pathway Assessment and Evaluation.

CASE STUDY

Saskatchewan Uranium Mines: Presenting Complex Relationships Using Pathway Diagrams

Several uranium mines were proposed at the same time in northern Saskatchewan (➧ Appendix B). The cause-effect relationships between radiation sources and the environment were modelled using pathway diagrams (Ecologistics 1992). These diagrams, resembling flowcharts, provide a simplistic representation of complex dose-receptor linkages. The diagrams offer at least two benefits: 1) they assist in analysis by breaking-down complex relationships into simpler, more manageable components; and 2) they provide an effective means of communicating these relationships for the purposes of review and discussion.

Network diagrams always start at one "high-level" point from which each subsequent linkage describes an increasingly more precise component affected.[20] In the Uranium Mine assessment, a network diagram was used to illustrate linkages between a radiation source and the atmosphere, groundwater and surface water. This included linkages from each of these to a combination of more specific environmental components, such as vegetation, soil, forage crops, animal produce, aquatic plants, aquatic animals and sediment. The diagram concludes with a total dose received by these components.

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[19] An early example of the use of Impact Models is the Beaufort Environmental Monitoring Program (LGL *et al.* 1984). This program was initiated to provide the technical basis for establishing research and monitoring priorities related to future oil and gas development in the Beaufort Sea.

[20] Network diagrams resemble pathway diagrams in Impact Models; however, network diagrams are simpler in that they do not necessarily represent a specific scientific hypotheses, and do not necessarily have linkages that are individually defined and validated.

CASE STUDY

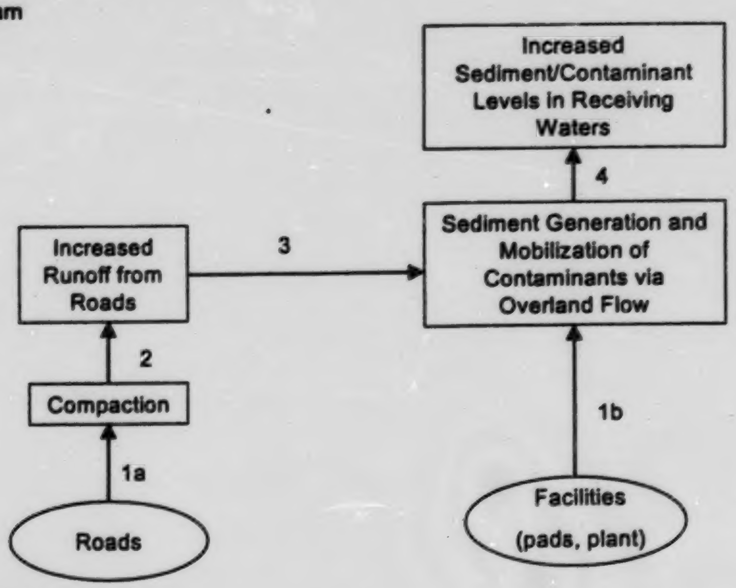
Cold Lake Oil Sands Project: Applying Impact Models

The following provides an example of an Impact Model (from a total of 35 for the EIA) developed to assess the effects of the Cold Lake Oil Sands Project on surface water quality (IORL 1997b).

Impact Statement

Operation and maintenance of roads and facilities will result in the generation of sediment and transport of contaminants to receiving waters.

Pathway Diagram


Increased Sediment/Contaminant Levels in Receiving Waters
4
Sediment Generation and Mobilization of Contaminants via Overland Flow
Increased Runoff from Roads
3
2
Compaction
1a
Roads
1b
Facilities (pads, plant)

Linkage Statements

1a. The operation and maintenance of roads will lead to compaction of the roadbed.

1b. Operation and maintenance of pads and plant facilities will result in the generation of sediment and mobilization of contaminants via overland flow from these facilities.

2. Compaction will cause an increase in surface runoff from the road.

3. Increased runoff from roads will result in erosion of exposed soils, resulting in an increase in sediment generation and transport. Soluble contaminants from the road and the road bed will be transported along with the sediment.

4. Increased sediment and contaminant transport will result in higher levels of these parameters in receiving waters, which will result in a decline in surface water quality.

Linkage Validation

#	Linkage Description	Validity	Confidence
1a	The operation and maintenance of roads will lead to compaction of the roadbed.	Valid	High
1b	Operation and maintenance of pads and plant facilities will result in the generation of sediment and mobilization of contaminants via overland flow from these facilities.	Valid	High

(cont . . .)

2	Compaction will cause an increase in surface runoff from the road.	Valid	High
3	Increased runoff from roads will result in erosion of exposed soils, resulting in an increase in sediment generation and transport. Soluble contaminants from the road and the road bed will be transported along with the sediment.	Valid	High
4	Increased sediment and contaminant transport will result in higher levels of these parameters in receiving waters, which will result in a decline in surface water quality.	Valid	High

Pathway Assessment and Evaluation

Pathway	Links	Scope	Magnitude	Duration	Frequency	Direction	Significance	Confidence
1	1a,2,3,4	Local	Moderate	Long-term	Continuous	Negative	Insignificant	High
2	1b,4	Local	Moderate	Long-term	Continuous	Negative	Insignificant	High

3.3.2.2 *Spatial Analysis using GIS*

Spatial analysis using a Geographic Information System (GIS) involves assessing the effects of the action under review on a component of the *entire* surrounding environment in which all the actions and natural features are combined together into one representative model of the landscape (this may be done on a scenario-by-scenario basis). The essential feature of a GIS is that it correlates measures of disturbance to various actions, and then relates those disturbances to the occurrence of VECs. This allows the creation of a model representing certain cause-effect relationships. Furthermore, relatively large areas can be readily examined (assuming adequate descriptive data in spatial form is available) and quantitative results produced.

Typical GIS applications include the determination of:

- area of land cleared (causing removal of vegetation and disturbance to soils);
- distances between (or overlap of) effects on other actions or natural features;
- length and density of road access;
- area of land in which wildlife are subject to sensory alienation;
- area of wildlife habitat lost or of reduced capability (➡ Figure 3 for an example);
- degree of habitat fragmentation; and
- changes in any of the above between assessment scenarios.

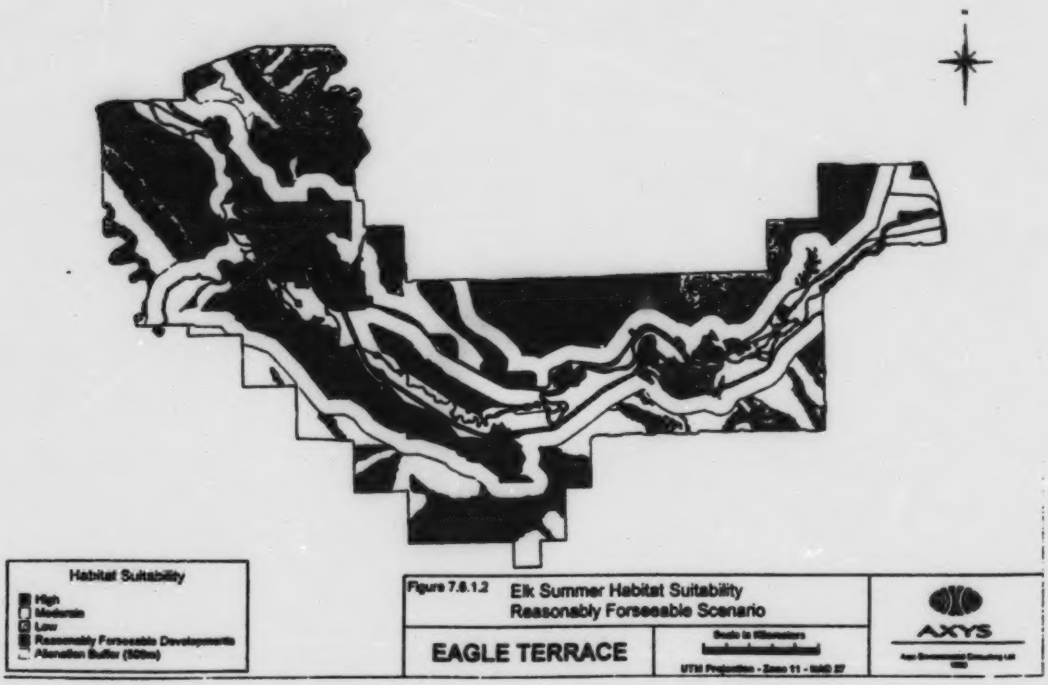
Regional Landscape Spatial Analysis: Using GIS to Identify Wildlife Habitat Suitability

Geographic Information Systems (GIS) allow a practitioner to develop and apply models that quantitatively assess changes due to land disturbances over large areas. A common application of GIS is the assessment of loss and fragmentation of wildlife habitat. This approach was used in the assessments (➡ Appendix B) of the Trans-Canada Highway Phase IIIA, Eagle Terrace, Cold Lake Oil Sands and Cheviot Mine projects.

In each of these cases, a system of ecological land classification or vegetation community mapping was used to classify similar land units within the regional study area. These types were then translated into habitat suitability, which was mapped to indicate areas of low, moderate and high suitability. When superimposed on a map of disturbances (e.g., the proposed action, roads, powerlines, other industrial activity), the area of habitat lost could be determined. With an alienation buffer placed around each disturbance, the additional area lost or of reduced habitat capability due to alienation (e.g., noise, light) could also be determined. A buffer consists of a certain distance from the source of an effect (e.g., a highway) and a "disturbance factor" that quantifies the probability of an animal residing in that buffer.

This approach (along with air and water quality models) provides one of the few currently available techniques of assessing large-scale changes on a specific environmental component.

Figure 3: Assessing Regional Wildlife Habitat Change using a GIS
Loss of high, moderate and low habitat was calculated for elk in a mountain valley already experiencing extensive development (the central black areas indicate areas of development; the shaded areas indicate levels of quality of habitat; the white areas surrounding developments, such as the Trans-Canada Highway, are wildlife disturbance buffers) (Eagle Terrace 1996).


Habitat Suitability
High
Moderate
Low
Reasonably Forseeable Developments
Alienation Buffer (500m)
Figure 7.8.1.2
Elk Summer Habitat Suitability
Reasonably Forseeable Scenario
EAGLE TERRACE
Scale in Kilometers
UTM Projection - Zone 11 - NAD 27
AXYS

3.3.2.3 Indicators

Indicators provide a specific measure of the effects on a VEC. An indicator may sometimes actually be the VEC itself. Indicators used in a CEA may differ from those used in an EIA if indicators for local effects do not adequately represent effects at a larger spatial scale or longer timeframe. For example, in the case of a pulp mill where suspected contamination of a river is an issue, the VEC for the assessment would be water quality. An indicator for local effects (i.e., as used in the EIA) could be dissolved oxygen to measure effects a few kilometres downstream. An indicator for regional effects (i.e., as used in the CEA) could be dioxin concentrations in fish 200 km downstream where a small fishing community lies along the river.

Indicators can measure attributes of human-caused disturbances (e.g., road densities, area cleared) or attributes of the surrounding environment (e.g., fragmentation indices, biodiversity indices, length of edge).

Indicators

CASE STUDY

Eagle Terrace Sub-division: Using a Variety of Wildlife Indicators

Three wildlife species were chosen as indicators of change in response to development pressures in a mountain valley: elk, wolf, and Swainson's Thrush (Eagle Terrace 1996). Elk was used to assess use by ungulates and to serve as an ecological indicator of use of early seral habitats in the valley. Wolf was used to assess use by large-carnivores and to serve as an ecological indicator of large-scale regional wildlife movements. Swainson's Thrush was used to assess use by songbirds and to serve as an ecological indicator of localized fragmentation of forest habitat.

CASE STUDY

Alliance Pipeline: Landscape Indicators

The Alliance pipeline has been proposed to connect gas fields in north-eastern B.C. to the U.S. border at Saskatchewan. Extending almost 1700 km, the pipeline would pass through many different biophysical regions. The CEA analyzed effects in six different study areas along the route, each representative of certain ecological conditions (Alliance 1997). Several "Landscape Indices" were used to quantify various natural and constructed features. The values obtained were compared to published thresholds of tolerance, if available, for several terrestrial and avifauna indicator species: moose, grizzly bear, marten, black-throated green warbler, trumpeter swan, sharp-tailed grouse and long-billed curlew.

The Landscape Indices included:

- access density (right-of-way km/km^2) as an indicator of habitat effectiveness;
- stream crossing density (crossings/km of streams in each study area) as an indicator of aquatic disturbances;
- cleared area (ha) as an indicator of regional habitat availability and fragmentation;
- edge area (ha) as an indicator of regional habitat availability; and
- core area (ha) as an indicator of regional habitat availability, fragmentation and connectivity.

Using Road Density to Indicate Regional Landscape Change

The issue of road proliferation (an example of an induced action) is a major concern in areas undergoing extensive development, especially in previously undeveloped hinterland areas. Each additional action will often directly add more road access to a region, which can induce additional activity (e.g. hunters using ATVs) and further development making use of this access.

The growing network of roads and vehicular traffic represent an increasing alteration of land surface and sensory disturbance. For wildlife, this represents an incremental direct and indirect (i.e., alienation) loss of habitat which leads to habitat fragmentation and blockage of wildlife movements.

Mapping the road network over many years can be used to demonstrate how various actions have contributed cumulatively to large-scale regional changes in the landscape. Roads can then be used as a quantitative indicator of cumulative effects. Road density (i.e., km road/km^2 of landscape) is usually calculated for various points in time (e.g., years 1930, 1960, 1980 and 1990).

Taking this approach one step further, a specific road density may be selected as a regional threshold for a particular species (➔ Section 3.5.3).

3.3.2.4 Numerical Models

Numerical models are algorithms that are used to simulate environmental conditions. The most common use of these models is to predict the state of a physical or chemical constituent by using a computer-based application to assess air and water quality, water volume flows, and airborne deposition on soils and vegetation. Terrestrial and aquatic organisms are relatively more difficult to model than effects on air and water systems due to uncertainties in predicting their behavioral and physiological responses.

Air and water modelling has typically followed a cumulative effects approach: the distances in which airborne or waterborne constituents are typically transported has often necessitated a regional perspective. Because of this, the use of readily available numerical models may provide an adequate assessment response to cumulative effects on air and water quality.[21] In some assessments, the spatial boundaries of the airshed or watershed modelled have been used as an overall regional study area if it adequately addresses effects on other environmental components.

CASE STUDY
Steepbank Mine: Regional Air Emissions Modelling

A regional air emissions analysis was performed for a proposed oilsands project in Alberta (Suncor 1996). Emission rates (t/d) were determined for four sources and totaled for each of five air quality indicators.

Emission	Suncor	Syncrude	Other Industry	Traffic/ Residential	Total
SO_2	233.5	207.4	0.1	0.2	441.2
NO_x	37.1	31.7	0.5	1.3	70.6
CO_2	9643	23733	1101	587	35064
VOCs	42.3	17.2	3.0	2.3	64.8
particulates	6.8	13.9	0.3	2.9	23.9

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[21] In some cases, specific models may be required to meet statutory requirements for permit or license applications.

CASE STUDY
Combining Numerical Models and GIS: Coastal Temperate Rainforest in Clayoquot Sound

The Coastal Temperate Rainforest Simulation Model (ESSA 1992) was developed to predict possible future changes in the coastal rainforest depending on various types and rates of change. A raster spatial database for various watersheds in the Sound was combined with various models that simulated certain conditions over many years. Map-based data included road access, forest age and percentage fines from streams. Model variables included volume timber harvest, economic indicators and habitat characteristics. A series of mathematical functions correlated the magnitude between various attributes (e.g., the sigmoidal-function response of egg to fry mortality due to increasing levels of fines in the streams caused by nearby timber harvesting). Models simulated timber harvesting, sediment movement and effects on salmon and its habitat.

3.4 STEP 3: IDENTIFICATION OF MITIGATION

Managing cumulative effects in a CEA requires, as a start, the same type of mitigation and monitoring that would be recommended in an EIA. Mitigating a local effect as much as possible is the best way to reduce cumulative effects; however, to be most effective, mitigation and monitoring must be long term and regionally based.[22] This can be costly, require a few years to complete, and require broader data collection and decision-making involvement than has historically been the case with EIAs (monitoring programs for individual actions are usually designed with the involvement of regional administrative bodies).

The mitigation measures applied in CEAs (e.g., as proposed for the Cheviot Mine project) may be considerably different from those applied in traditional EIAs. These mitigation measures can be applied to developments other than the proposed development (e.g., through pollution trading). Several administrative jurisdictions and stakeholders will usually fall within an assessment's regional study area. In many cases, the co-operation of these other interests may be required to ensure that recommended mitigation is successfully implemented. Effective CEAs, therefore, often imply the need for regional stakeholder involvement to solve regional concerns. Considerable reliance is placed on regional efforts to mitigate cumulative effects, such as initiatives to create regional co-ordinating bodies that direct or recommend further land use, monitoring and other effects-related research. Participants are usually selected from provincial and federal ministries, stakeholder groups and commercial interests. The objectives of these initiatives are generally to protect landscape-scale patches and inter-connecting wildlife corridors, and disperse permanent and transient human activities to reduce the magnitude of cumulative effects.

Recommendations for regional initiatives of this type may be the only means of addressing complex cumulative effects issues. It is generally unreasonable to expect a single proponent to bear the burden of mitigating effects attributable to other actions in the region. Often it is more practical and appropriate for regulatory agencies to initiate and help implement these regional initiatives, with project proponents providing data relevant to their project's effects.

"No Net Loss" as a Mitigation Measure

The concept of "no-net loss" has been suggested by some regulatory agencies as an appropriate mitigation measure in response to regional cumulative effects concerns. No-net loss requires that any land or waterbody disturbed from its pre-action condition be "replaced" with an area of equivalent capability to ensure that capability of habitat to support wildlife or fish is maintained in the region (this includes the option of increasing the productivity of existing habitat).

This concept presents two challenges as an effective approach to offsetting cumulative loss of terrestrial habitat:

- To create "more land", existing land must be converted (e.g., through habitat modification). However, it is typically converted to conditions that benefit one or a few select species (e.g., rare or game species). By implication, this may be a detriment to other species and may not represent a habitat of equivalent capability to support the full range of species originally supported by the lost habitat.
- There may be no remaining land within a reasonable distance of the action to be modified (i.e., within a distance that beneficial effects would be attributable to the action). This is particularly true for regions with extensive private land holdings or existing disturbances, land that would be inaccessible to wildlife, and when vegetation climax conditions are required.

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[22] Another response to addressing effects is compensation (usually financial) for losses in some form to a person or personal property. Compensation, however, is not mitigation.

When Other Actions Contribute More to Cumulative Effects

What happens if an existing action is found to already be contributing most to cumulative effects in a region? Typically, the administrative jurisdiction of the agency reviewing the action can only address mitigation for the proposed action. Mitigating effects caused by the proposed action may solve *local* effects, but do little to ameliorate the *regional* cumulative effects. In these cases, the reviewing agency or Board (if within its legislative authority) may consider mitigation of effects from existing actions as a condition of approval for the action under review.

CASE STUDY

Huckleberry Copper Mine: Implications of Mandatory Mitigation

The Huckleberry Copper Mine was proposed in central-west British Columbia (➡ Appendix B). The application of mandatory mitigation measures for discharges to waterways meant that cumulative effects on water quality were unlikely and insignificant (HCPC 1995). Such mitigation measures would ensure that regulated water quality objectives would be met.

CASE STUDY

Trans Canada Highway Twinning: Wildlife Crossing Structures

To mitigate obstruction of wildlife movements, the Trans Canada Highway CEA (Parks Canada 1994) proposed that culvert underpasses be built at various locations along the proposed highway twinning project (➡ Appendix B). However, due to concerns about use by large carnivores, the assessment further recommended that usage of these structures by wildlife be monitored for several years to determine which location would best facilitate regional movements. If use was subsequently deemed inadequate, the assessment further proposed that a wildlife overpass be constructed (as overpasses were known to be more effective than underpasses). Later review of wildlife movements resulted in the recommendation of immediate construction of two overpasses.

CASE STUDY

Express Pipeline: Reclamation of Native Prairie as Mitigation

The proponent contended that cumulative effects on native prairie were not significant given that most of the project disturbance would be local to the pipeline right-of-way and mitigable (Priddle *et al.* 1996). Most of the project consisted of buried pipeline; any disturbed soils and vegetation along the 30 m right-of-way would be reclaimed. It was expected that 80% of the vegetative composition of the right-of-way would be similar to pre-disturbance conditions within five years, and full recovery of the different botanical components would occur within 20 years. No long-term substantial effects on wildlife were expected as a result of clearing or fragmentation.

CASE STUDY
Energy Projects in Alberta's Eastern Slopes: Responses to Development Pressures

In the early 1990s, the Eastern Slopes of Alberta's Rocky Mountains underwent an increase in oil and gas exploration. In some cases, leases were being issued and actions proposed for areas considered by various environmental interest groups as environmentally significant. Although there was a regional land use plan in effect (referred to as an Integrated Resource Plan), it was not sufficiently stringent or specific in land use zoning to consider specific local areas of concern or larger regional cumulative effects.

In response to these concerns, a multi-stakeholder group represented by the Alberta government, the oil and gas industry, and environmental groups was established in 1993. The purpose of this group, referred to as the Eastern Slopes Energy and Environment Committee, was to identify and reach a consensus on areas that should be restricted from further oil and gas activity for environmental reasons. Although various areas were agreed upon, the Committee disbanded in 1995 without this goal being achieved.

At the same time, the provincial regulatory agency for the oil and gas industry (the Alberta Energy and Resources Board) issued an Information Letter or guideline that described actions and assessment issues that were to be addressed by proponents submitting applications for actions in the Eastern Slopes (ERCB 1993). The Letter requested that proponents attempt to consolidate their plans through sharing of data and use of common roads and utilities (e.g., pipelines, transmission lines) to minimize surface disturbance. In general, proponents were requested to take a lead role in identifying and addressing issues in the region.

CASE STUDY
Cheviot Coal Mine: Carnivore Compensation Package

In 1996 Cardinal River Coal proposed to construct a coal mine east of Jasper National Park in Alberta. The proponent recognized that regional initiatives were required to mitigate significant effects: some that it could undertake, others that would require a coordinated effort. In the former case, impacts on water quality, old growth forest, rare plants, land use and recreational access, Harlequin duck, and elk could be addressed by the proponent alone. However, regional initiatives would be required to address cumulative effects on grizzly bear.

To compensate for some unmitigable losses to carnivore habitat, it was recommended that a "Cheviot Carnivore Compensation Program" be established (CRC 1996). This program would contribute to funding regional research on large carnivore ecology, establishing and supporting a Wildlife Management Board, and offering regional-oriented education packages. Existing regional initiatives were also recognized, such as the establishment of new natural areas (e.g., recent creation of Cardinal Divide Natural Area, Foothills Model Forest), and the Coal Branch Access Management Plan in the Coal Branch Sub-regional Integrated Resource Plan. Natural areas, along with Jasper National Park, were cited as offering protected reserves that may be used by any wildlife displaced by the mine. An Access Management Plan could also be used to reduce adverse effects by limiting vehicular access, hunting and noise.

CASE STUDY
West Castle Valley Resort: Wildland Recreation Area

In 1993, the Alberta Natural Resources Conservation Board followed a CEA type approach during its hearings on an application for a project in the West Castle Valley, located in the foothills of the Canadian Rockies near Pincher Creek, Alberta (Smith *et al.* 1993). The project included a four-season destination resort, with visitor accommodation and recreational facilities.

The practitioner, and subsequently the Board, adopted a gradual progression of inquiry to ensure that impacts of the project on far-ranging wildlife were understood. For example, the assessment of grizzly bears required a much larger area (more than 10 times the EIA study area, extending into the U.S.) to be examined to determine whether the project would threaten the regional grizzly population. Evidence presented to the Board suggested that the project would block one of three wildlife corridors that linked important habitat to the north and south of the project. This suggested that potential effects of the project on grizzlies could threaten the viability of the population. Furthermore, historical precedent demonstrated how this species had been extirpated from other range in North America as a result of direct mortality and increased fragmentation of habitat.

There was no overt decision to assess cumulative effects. Rather, the weight of evidence led to the need to consider a larger spatial scope; historical evidence of effects on bears; and implications for bear populations in the future. Ultimately, the Board had to determine whether there was any room for alternative corridors to mitigate the project's effect. This resulted in the Board's decision that the project should not proceed unless a nearby area is rezoned as a "Wildland Recreation Area".

CASE STUDY
Northern River Basins Study: Watershed Monitoring

In 1989, a joint federal-provincial Review Board (DeSorcy *et al.* 1990) held hearings into the proposed Alberta-Pacific Forest Industry's pulp mill (➔ Appendix B). Located in the boreal forest north of Edmonton, the mill would discharge waste process water into the Athabasca River, part of the larger Athabasca-Peace River watershed that encompasses parts of British Columbia, Alberta and the Northwest Territories.

The need for a regional study grew out of recommendations during the Board review for more regional scientific data. The Board was concerned that impacts from the mill as well as existing and future actions might adversely affect the region's watersheds. A major component of the study was a public consultation process, involving residents throughout the region.

The Northern River Basins Study was then initiated in 1990 to "examine the relationships between development and the Peace, Athabasca and Slave River Basins" (NRBS 1993), an area that includes much of northern Alberta. This three-and-a-half year, $12.3 million project, under the provisions of the *Canada Water Act*, was jointly funded by the Government of Canada and the Province of Alberta, with involvement of the Northwest Territories Government. Operations were co-ordinated by a Study Board representing various regional stakeholders, with assistance from a Science Advisory Committee.

The Study Board co-ordinated various research projects to identify data gaps, provide an environmental baseline database on contaminant levels, develop models to assess cumulative effects of development on the aquatic environment, and assist future regional planning efforts. Research was directed towards examining the effects of toxic compounds in the waterways and developing predictive tools to assess the cumulative effects of multiple sources in those waterways.

3.5 STEP 4: EVALUATION OF SIGNIFICANCE

3.5.1 Approaches to Determining Significance

Determining the significance of residual effects (i.e., effects after mitigation) is probably the most important and challenging step in EIA. The determination of significance for CEAs is fundamentally the same; however, it may be more complex due to the broader nature of what is being examined. A cumulative effects approach requires determining how much further effects can be sustained by a VEC before suffering changes in condition or state that cannot be reversed.

Significance

Deciding Whether Effects are Likely

The *Canadian Environmental Assessment Act* states that "any cumulative environmental effects that are likely to result..." must be considered. According to guidance provided by CEAA (1992), the following questions should be asked:

1. Are the environmental effects adverse?
2. Are the adverse environmental effects significant?
3. Are the significant adverse affects likely?

The determination of likelihood is based on two criteria: 1) probability of occurrence and 2) scientific certainty. In practice, likelihood as an attribute of significance (➡ *Cold Lake Oil Sands Project: Significance Attributes* for examples of other attributes) is often rated on a scale: e.g., None (no effect will occur), Low (<25% or minimal chance of occurring), Moderate (a 25% to 75% or some chance of occurring), and High (>75% or most likely a chance of occurring).

Query for Evaluating Significance

Significance conclusions in assessments should be defensible through some form of explanation of how the conclusions were reached. The following is an example of one approach (Duval and Vonk 1994). A series of questions are structured so as to guide the practitioner through a series of steps, eventually leading to a significance conclusion. The questions follow a basic line of inquiry as follows:

- Is there an increase in the action's direct effect in combination with effects of other actions?
- Is the resulting effect unacceptable?
- Is the effect permanent?
- If not permanent, how long before recovery from the effect?

In more detail, these questions appear below, specifically to address the nature of two different types of VECs.

Biological Species VECs

- How much of the population may have their reproductive capacity and/or survival of individuals affected? Or, for habitat, how much of the productive capacity of their habitat may be affected (e.g., <1%, 1-10%, >10%)?
- How much recovery of the population or habitat could occur, even with mitigation (e.g., Complete, Partial, None)?
- How soon could restoration occur to acceptable conditions (e.g., <1 year or 1 generation, 1-10 years or 1 generation, >10 years or >1 generation)?

Physical-chemical VECs

- How much could changes in the VEC exceed that associated with natural variability in the region?
- How much recovery of the VEC could occur, even with mitigation?
- How soon could restoration occur to acceptable conditions?

CASE STUDY
Cold Lake Oil Sands Project: Significance Attributes

Determining the significance of effects associated with the Cold Lake Oil Sands project was, in part, based on conclusions reached for seven "Significance Attributes" (IORL 1997a). These attributes have generally gained common acceptance amongst EIA practitioners (although the definitions may vary) as a means of identifying and measuring various aspects of an effect that collectively assist in the evaluation of significance.

Attribute	Options	Definition
Direction	Positive	Beneficial effect on VEC
	Neutral	No change to VEC
	Negative	Adverse effect on VEC
Scope	Site	Effect restricted to a small site
	Local	Effect restricted to the project footprint
	Sub-regional	Effect extends to area within a few kilometres of the project footprint
	Regional	Effect extends throughout regional assessment area
Duration	Short-term	Effects are significant for <1 year before recovery returns conditions to the pre-project level; or, for species, for less than one generation
	Medium-term	Effects are significant for 1-10 years; or, for species, for one generation
	Long-term	Effects are significant for >10 years; or, for species, for more than one generation
Frequency	Once	Occurs once only
	Continuous	Occurs on a regular basis and regular intervals
	Sporadic	Occurs rarely and at irregular intervals
Magnitude	Low	Minimal or no impairment of component's function or process (e.g., for wildlife, a species' reproductive capacity, survival or habitat suitability; or, for soil, ability of organic soil to fix nitrogen)
	Moderate	Measurable change in component's function or process in the short and medium duration; however, recovery is expected at pre-project level
	High	Measurable change in component's function or process during the life of the project or beyond (e.g., for wildlife, serious impairment to species productivity or habitat suitability)
Significance	Insignificant Significant Unknown	Based on the analysis, use of Significance Query, and best professional judgment, is the effect on the VEC significant?
Confidence	Low Moderate High	In general, what is the confidence level in the conclusion?

3.5.2 Factors that Influence Interpretation of Significance

A cumulative effect on a VEC may be significant even though each individual project-specific assessment of that same VEC concludes that the effects are insignificant. This is a fundamental principle in the understanding of cumulative effects. Project-specific assessments, that focus on the incremental contribution of the project being assessed, can assist in making such conclusions as they must consider the implications of other actions also affecting the VECs. However, this inclusion (and sometimes the analytical approach used) requires the consideration of various factors that may influence the determination of significance (some which have not always been an issue in earlier assessments without a cumulative effects component). These factors include the:

- exceedance of a threshold;
- effectiveness of mitigation;

- size of study area;
- incremental contribution of effects from action under review;
- relative contribution of effects of other actions;
- relative rarity of species;
- significance of local effects;
- magnitude of change relative to natural background variability;
- creation of induced actions; and
- degree of existing disturbance.

Each of these points are discussed below in detail.

- ***Significance may increase if a threshold is exceeded***: If the magnitude of an effect exceeds a threshold for a VEC, and the effect is not brief in duration, then the effect is usually considered significant.
- ***Significance may increase as the effectiveness of mitigation measures decreases***: Determination of the significance of *residual* effects on a VEC is the most important outcome of an assessment. The effectiveness of recommended mitigation measures should, therefore, be acknowledged in the assessment (mitigation that is 100% effective will result in no residual effects).
- ***Significance may appear to decrease as the study area size increases***: An assessment approach used in many CEAs involves comparing increases in area covered by successive actions in a region. The assessor can determine how much the action under review has contributed to the incremental historical and existing land uses. In such assessments, the study area against which the comparison is made is usually fixed, resulting in comparison against the same reference point. Therefore, the larger the study area, the smaller the apparent contribution of each action to change. In this way, the incremental contribution of even a large action may appear to be insignificant (e.g., <1%) if the study area is sufficiently large. To avoid misleading conclusions, the practitioner should also demonstrate how much change is attributable to the action under review when compared to other actions in the study area (as opposed to the study area itself).

CASE STUDY

Eagle Terrace Sub-division: Comparing Incremental Effects of a Project

In the Eagle Terrace assessment (Eagle Terrace 1996), the loss of songbird (Swainson's Thrush) habitat was calculated in two ways. It was first determined that existing developments caused a 38% loss of moderate quality habitat, reasonably foreseeable actions would cause a further loss of 7.2%, and the proposed Eagle Terrace project would cause a further incremental loss of only 0.1%. These numbers were based on a comparison to a fixed area: the regional study area.

However, the percentages were then re-calculated and compared to the land *remaining* undisturbed after each scenario (which becomes progressively smaller). In this case, the loss of habitat changed to 47%, 17% and 0.2% respectively. Although the contribution of the proposed project would double, it remained considerably less than 1% (usually a value of change considered insignificant in assessment practice). The contribution of all other actions, however, would more than double to considerably more than 10% (a value usually considered significant).

- ***Significance may decrease as the relative contribution of an action decreases***: It can be argued that if the effects of an action within a regional study area are quite small relative to the effects of other actions in that same area, then the cumulative effects of that action are likely to be negligible. For example, if a forest cutblock of 4 ha is proposed within a region in which there are already 300 ha of clearcut areas, then the proposed action contributes an incremental loss of potential wildlife habitat of only 1.3%. The validity of this argument depends somewhat on the size of the study area (the larger the regional study area, the smaller the percentage becomes). The argument may not hold true in all cases, especially if that 4 ha supports plant species that are regionally rare, provides particularly important habitat for wildlife (e.g. salt licks for ungulates) or has a unique topographical feature. Furthermore, the argument may not hold if that further loss of 4 ha causes a threshold to be exceeded for a certain VEC, beyond which the VEC can not recover. However, applying this "straw-that-breaks-the-camels-back" view of the implications of adding one more action are often handicapped by the lack of clearly defined thresholds.
- ***Significance may decrease as the significance of nearby larger actions increase***: For an action proposed in close proximity to larger existing actions, its relative contribution to cumulative effects may be minimal. Although this does not mean that a CEA is not required, it *does* suggest that the effects of the other action(s) should be adequately understood.
- ***Significance may increase as a species becomes increasingly rare or threatened***: The significance of effects on a species' population may have to consider the rarity of the species at larger scales (e.g., regional, provincial or global). To illustrate for biological organisms, consider a population of 200 animals or plants living within the "footprint" of a proposed action. Such a population might be severely affected. The importance, however, that is attributed to such an effect will almost certainly depend on whether the population is part of a local, regional or global population of 200, 2000 or 200 million. In addition, it must also be considered if *that* remaining population itself is rare or threatened.
- ***Significance may decrease as the significance of local effects decrease***: It has been argued that if the conclusions of an EIA indicate that none of the residual direct effects are significant, then there will be no cumulative effects (as therefore there are no effects remaining to act cumulatively with other actions). While this may be true for some types of effects, this may not always be the case: *an insignificant local effect may still contribute to a significant cumulative effect!*

  The argument of insignificance may be true, for example, if mitigation eliminates or substantially reduces the transport of a constituent elsewhere (e.g., a contaminant discharged into a waterway) or the emanation of a sensory disturbance (e.g., noise). In these cases, the potential for cumulative effects with other actions will be reduced.

  However, the argument may be false if, on a regional scale, there nonetheless remains an important *indirect* effect that results in a regionally important loss of a VEC (e.g., loss of 10% of the population of a rare plant species with the study area) or of a resource on which the VEC depends (e.g., fragmentation of wildlife habitat). This indirect effect most commonly occurs as a result of the clearing of land which, although perhaps not significant at a local scale, may have important regional implications (i.e., the nibbling effect). In these cases, the practitioner must recognize this possibility and, while determining significance, consider the relative scarcity of what is being affected.
- ***Significance may decrease if effects are within natural background variability***: If a *direct* effect causes no detectable change in a VEC, then the effect would usually be considered insignificant. If the change caused by the effect is detectable but within the magnitude of naturally fluctuating conditions (e.g., annual water temperatures and flows, percentage

dissolved oxygen, seasonal wildlife population size), then the effect would also usually be considered insignificant. However, these arguments may not remain true if a number of individual actions each contribute small incremental changes, each below natural variability, which eventually causes a detectable change and exceedance of natural background conditions. For example, the effects of a series of placer mines or pulp mills along the same river may individually be considered insignificant due to adequately applied mitigation (e.g., the sediment or pollutants are diluted below background levels). However, their cumulative downstream effects may exceed even worst-case natural conditions (e.g., during periods of drought). Furthermore, there is often considerable uncertainty associated with identifying natural variability; its use for comparison purposes must therefore be approached with caution.

- ***Significance may increase as the number of induced actions increase***: A proposed action may induce new actions to occur in the region. Although considering these spin-off actions in the CEA implies some certainty that they will occur, greater significance may be borne by the effects of the action under assessment.
- ***Significance may decrease if the surrounding environment is already heavily disturbed***: An action proposed in a region already heavily disturbed due to existing actions may not be significant if environmental components are already compromised (e.g., thresholds have been exceeded). For example, a pipeline could be proposed in an area already crossed by numerous other rights-of-way (e.g., access roads), in which case the pipeline itself would not necessarily be an important contributing cause to a possible collapse of a wildlife population.

3.5.3 Using Thresholds

Thresholds are limits beyond which cumulative change becomes a concern, such as extensive disturbance to a habitat resulting in the rapid collapse of a fish population, or when contaminants in soil suddenly appear in potable water supplies. Thresholds may be expressed in terms of goals or targets, standards and guidelines, carrying capacity, or limits of acceptable change, each term reflecting different combinations of scientific data and societal values. For example, a threshold can be a maximum concentration of a certain pollutant beyond which health may be adversely affected, a maximum number of hectares of land cleared from its existing natural state before visual impacts become unacceptable, or a maximum number of deer lost from a valley habitat before the viability of the population is threatened.

Making useful conclusions about cumulative effects requires some limit of change to which incremental effects of an action may be compared. Theoretically, if the combined effects of all actions within a region do not exceed a certain limit or threshold, the cumulative effects of an action are considered acceptable. In practice, however, the assessment of cumulative effects is often hindered by a lack of such thresholds. This is particularly true for terrestrial components of ecosystems. Contaminants affecting human health and constituents in air and water are usually regulated; therefore, thresholds useful for assessment purposes are defined by regulation or available in guidelines (e.g., Health Canada's drinking water quality guidelines).[23]

There is not, therefore, always an objective technique to determine appropriate thresholds, and professional judgment must usually be relied upon. When an actual capacity level cannot be determined, analysis of trends can assist in determining whether goals are likely to be achieved or patterns of degradation are likely to persist.

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[23] Consideration of human health is often implicit is some assessments of biophysical components (e.g., air quality).

In the absence of defined thresholds, the practitioner can either: 1) suggest an appropriate threshold; 2) consult various stakeholders, government agencies and technical experts (best done through an interactive process such as workshops); or 3) acknowledge that there is no threshold, determine the residual effect and its significance, and let the reviewing authority decide if a threshold is being exceeded.

Thresholds

Carrying Capacity and Limits of Acceptable Change

Carrying capacity is the maximum level of use or activity that a system can sustain without undesirable consequences. This is very much a subjective determination, which depends on the values and context involved. Ecological carrying capacity reflects biophysical limits, while social or recreational carrying capacity may be determined largely by user perception and levels of satisfaction associated with a specific activity.

The concept of "limits of acceptable change" shifts the focus from identifying appropriate levels of use to describing environmental conditions that are deemed acceptable. The advantage of this approach is that once acceptable conditions have been described, the appropriate combination of levels of use and maintenance interventions required to sustain those conditions can be determined (Stankey *et al.* 1985, Wight 1994).

CASE STUDY

Placer Mining in the Yukon: Stream Sedimentation Thresholds

The Yukon Placer Authorization (GOC 1993) specifies maximum acceptable sediment discharge concentrations, based on acceptable effects on fish, for five different classes of streams. For example, the maximum concentration of sediment levels above natural background levels for Type III streams is 200mg/L (the type is based on fish bearing and harvesting attributes). Furthermore, some streams are uniquely classified on a series of mapsheets covering much of the southern Yukon. The cumulative effects implication of this Authorization is that any number of actions (i.e., placer mines) may occur on a single stream until the sedimentation limit is reached. This approach, therefore, provides a stream threshold that can assist in future decision making for actions affecting stream sedimentation.

CASE STUDY

Highwood River: Instream Flow Needs

The Alberta Government proposed to divert some of the peak flow volume of the Highwood River to supplement water supplies to a proposed reservoir. Concerns were raised about possible effects of water withdrawals on riparian vegetation and fish. A study (Yarranton and Rowell 1991) investigated how to determine minimum instream flow needs and what the flows should be. These flows represented a threshold, below which the survival of the VECs would be threatened. The flow was determined, based on best professional judgement, as the minimum flow requirements for various stream-related factors (e.g., vegetation regeneration, geomorphological changes, fish survivorship). The final threshold was selected as the highest volume flow required in each season for any one of those factors.

CASE STUDY
Banff National Park: Human Use and Grizzly Bear Thresholds

In a recent cumulative effects study by the Banff-Bow Valley Task Force, increased human use in Banff National Park was identified as causing a significant effect on the park's environment (BBVS 1996). In assessing these effects, a GIS was used to map levels of human use in the park on a 6-point scale, ranging from 10 persons per month to 1 million persons per month (each increment represented an increase in use by a factor of 10). As expected, backcountry trails experienced the least amount of use, while popular tourist areas, highways and townsites received the highest level of use.

Research in the park on grizzly bear-human interaction suggested that a limit of 100 persons per month (i.e., the second lowest level of use) would not exceed a threshold of tolerance for the bears during the summer (Gibeau *et al.* 1996). Since bears are not active in winter, the winter threshold of 1000 person per month was based on observed responses of wolves to human disturbances and activities (Paquet *et al.* 1996). These thresholds of use were then recommended to assist in future park management efforts in the park's backcountry. In the frontcountry (i.e., in highly developed areas), the thresholds obviously could not be applied; however, efforts were made in those areas to provide movement corridors so that large mammals (e.g., elk, wolf and bear) could effectively move into more suitable habitat.

In an assessment of the effects of expansion of the Trans Canada Highway in the park (Parks Canada 1994), it was suggested that habitat effectiveness of only 70 to 80% (compared to existing capability) could exceed the threshold of disturbance for grizzly bear. Another study in Yellowstone National Park provides a grizzly bear threshold based on a maximum tolerance of road density (Mattson 1993). The study suggests that road densities of greater than 0.4 km/km^2 in a region would greatly increase the likelihood that bears would be permanently alienated from the region.

3.5.4 Handling Uncertainty

Uncertainty in predicting effects and determining significance can arise due to variations in natural systems, a lack of information, knowledge or scientific agreement regarding cause-effect relationships, or the inability of predictive models to accurately represent complex systems. The degree of uncertainty in addressing cumulative effects is greater than for conventional EIAs because of a longer time horizon and larger study area.

It is recommended that the rules-of-thumb described below be considered when dealing with uncertainty.

Considerations when Handling Uncertainty

- Make conservative conclusions (i.e., assume that an effect is more rather than less adverse). This is referred to as the Precautionary Principle.[24]
- Provide a record or audit trail of all assumptions, data gaps, and confidence in data quality and analysis to justify conclusions.
- Recommend mitigation measures to reduce adverse effects and monitoring, followed by evaluation and management of effects, to ensure effectiveness of these measures.
- Implement mechanisms to evaluate the results of the monitoring and provide for subsequent mitigation or project modification, as necessary.

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[24] Other definitions exist of this term.

3.6 STEP 5: FOLLOW-UP

According to the *Canadian Environmental Assessment Act*, the purpose of follow-up is to verify the accuracy of environmental assessments and determine the effectiveness of mitigation measures. Follow-up in practice is normally recognized as monitoring and the establishment of environmental management measures. The federal Responsible Authority defines and implements the follow-up program. The proponent's responsibilities should be based on their specific action's contribution to cumulative environmental effects, given the understanding that it would usually be unreasonable for the proponent to solely monitor effects caused by other proponents.

The situations in which a follow-up is required include those where (Davies 1996):

- there is some uncertainty about the environmental effects of other actions, especially imminent ones;
- the assessment of the action's cumulative effects is based on a new or innovative method or approach; or
- there is some uncertainty about the effectiveness of the mitigation measures for cumulative effects.

4.0 DIFFERENT APPLICATIONS OF THE ASSESSMENT FRAMEWORK

The Assessment Framework described in Chapter 3 can be applied in various ways to meet the needs of different review requirements. Two of these are described in this section: assessing small actions (commonly referred to as "screenings"), and regional land use plans and studies.

4.1 ASSESSING SMALL ACTIONS

The majority of applications submitted to regulatory agencies for approval are for actions that do not require a detailed assessment and preparation of a formal EIA report. These actions are subject to a cursory or screening level review because they are relatively small in size and cause predictable and mitigable effects. Many small actions within the same area have the potential to cause cumulative (nibbling) effects. This often happens, for example, when many developments occur in rapid succession (e.g., a resource use boom). These types of actions may cause far more cumulative effects than one large action in the same area.[25]

Almost all CEA approaches discussed in the literature are intended for assessing large actions (i.e., relatively large in size or with a high likelihood of causing effects at a regional level). It may not always be feasible or necessary for practitioners conducting screening level assessments to carry out these often complex, time consuming and expensive tasks. It is government agencies themselves who often do all or most screenings in response to permit and license applications — some regulatory agencies must process thousands or tens of thousands of applications each year.

Therefore, there is a need to define a process by which cumulative effects of small actions can be considered at the screening level (e.g., as required under the *Canadian Environmental Assessment Act*) that takes into account the limitations of assessing cumulative effects at this level.[26] In effect, a "condensed" or "mini-CEA" is required, which is nevertheless based on all the approaches suggested in this Guide. Considerable work is still required to formalize such processes that are practical and easily implemented by reviewers.

In essence, addressing cumulative effects in small project screenings involves considering the potential effects that may arise from the project under review in terms of the broader context in which the project would occur. Such an analysis can be done quite effectively by considering three main aspects. First, it is helpful to consider the potential effects of the project under review from the perspective of general trends affecting the VECs (e.g., are there currently known trends of concern, such as gradual loss of water quality that could indicate a need to assess more closely the potential for interactions)? Second, would the project occur in an area where numerous other actions have taken place (e.g., for actions of a similar nature that could result in similar types of effects, such as shoreline modifications along a recreational waterway)? Third, are there any overall policies, thresholds or objectives that have been established at a strategic level of decision making that would be relevant (e.g., provincial guidelines or municipal master plans may establish relevant criteria for cumulative effects of projects such as stormwater outlets)?

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[25] It is also possible that "large" projects may be subject to a screening if, in the case of review under the *Canadian Environmental Assessment Act*, the project does not quite meet the particular specifications of the Act's *Comprehensive Study List*. For these larger projects subject to a screening, the Assessment Framework described in Chapter 3 may well be more appropriate.

[26] Class assessments have been proposed as one means of facilitating the expedient review of many similar projects of known, minor and mitigable effects; however, cumulative effects are normally considered on a project-by-project basis in class assessments.

It is also important to avoid a mismatch between the scale at which impacts accumulate and the scale at which decisions are made. In an ideal world, policies and plans would also undergo environmental assessments, which would include cumulative effects assessments. This would provide a context for addressing cumulative effects at the screening level. In reality, however, this does not always happen and screenings may raise issues that are well beyond the scope of the project under review. In such cases, the broader cumulative effects should be flagged so that they can be addressed at an appropriate level of decision making.

4.1.1 Elements of a Practical Design for a Screening Process

If cumulative effects are to be considered, they must be addressed in a simple and efficient manner that applies simple tests to the action and provides quick answers. The tests must also provide some indication of risk or likelihood of significance to determine if a more detailed review is required. The screener must be able to quickly make decisions; at no point should a screening process leave the screener wondering how to answer a complex question for which resources and time are not available to properly respond.

The following points should be considered when designing an assessment response for a particular agency. The approach should provide:

- a step-by-step process;
- a series of simple question-based criteria for determining rankings (e.g., significance);
- simple mechanisms to respond to typical CEA needs such as setting boundaries and identifying other actions;
- a mechanism to support requests for further information both within and outside the agency responsible for the review while ensuring that the screener's knowledge about the type of action and the geographic area can be incorporated;
- clear, concise questions that do not include terms open to interpretation (e.g., asking "is ecosystem integrity impaired?" would require "integrity" to be explicitly and practically defined);
- a written record to assist in later understanding on what basis decisions were made;
- clear decision points as to where to go next, including a "bump-up" mechanism (i.e., to move beyond screening to a more detailed level of review); and
- a customized response to the types of actions and effects of most concern to the reviewing agency (e.g., focussed on water-related issues for water use licenses) while at the same time identifying the possibility of any indirect effects that may lead to cumulative effects.

The following Case Study Information Boxes provide examples of how some agencies have begun to address cumulative effects at a screening level. It is suggested that users of this Guide review these and adopt and modify an approach suitable for their specific requirements.

Query for Assessing Small Actions

1. Will the action potentially affect ecosystems or VECs that are currently exhibiting trends of concern?
2. Will the action occur in an area where numerous other actions have taken place?
3. Are there any overall policies or plans that establish relevant objectives or criteria to facilitate the adoption of a broader perspective?

CASE STUDY

Parks Canada: A "Short-Cut" Approach

Parks Canada has recognized the need for a detailed CEA approach to address larger and more complex actions, and a short-cut approach to address cumulative effects for smaller actions (Kingsley 1997). The short-cut, a condensed version of the detailed approach, is simply an expedient way to determine if there are any potential impacts, and if so, if they may act cumulatively with other actions. This approach is summarized below.

Step 1: Scoping

A series of questions are first asked:

- Are the potential impacts of the action, as well as other existing stressors, occurring so closely over time that the recovery of the system is being exceeded?
- Are the potential impacts of the action, along with other stressors from other sources, occurring within a geographical area so close together that their effects overlap?
- Could the impacts from the action interact among themselves, or interact with other existing or known future stressors, either additively or synergistically?
- Do the potential impacts of the action affect key components of the environment? Have those components already been affected by other stressors from the same or other actions, either directly, indirectly or through some complex pathway?
- Is the action one of many of the same type, producing impacts which are individually insignificant but which affect the environment in such a similar way that they can become collectively important over the longer term (i.e., nibbling effect)?

If the answer to any of these questions is yes, there is a potential for cumulative effects. The following are then also asked:

- What are the potential impacts of the action that could give rise to cumulative effects?
- What is the appropriate scale to consider those impacts?

Step 2: Analysis

A matrix, describing various attributes affecting each VEC, is then completed. The attributes are: existing stressors affecting the VEC; pathways of change (cause-effect linkages); consequences (i.e., resulting trends of VECs); and contribution of the action to overall changes. Mitigation measures are also identified.

Step 3: Evaluation

The effects are evaluated, using best professional judgment, by asking if the identified changes affect the integrity of the environment as defined in Parks Canada guidelines. These changes are then compared with existing goals.

Step 4: Follow-Up, Feedback and Documentation

All information is documented, uncertainties identified, and feedback and monitoring requirements suggested in the Parks Canada Screening Form.

CASE STUDY
National Capital Commission: Stormwater Management Policy

The National Capital Commission (NCC) is a federal Crown corporation responsible for planning and assisting in the development, conservation and improvement of the region surrounding Ottawa. An important component of the NCC's plans for the capital region is public accessibility to waterfront areas; as a result the NCC owns and manages large areas of river shoreline. Because of this, private developers and/or municipalities occasionally requested authorization to built stormwater outlets or retention ponds on NCC river shoreline. The river system spans two provinces and several local municipalities, and broad guidelines were either not available or were jurisdiction-based. In a screening for a proposed stormwater outlet, the potential for cumulative effects was flagged. The screening recommended mitigation measures for treating stormwater but also highlighted the need for a broader stormwater management policy. This policy has since been formally adopted by the NCC and provides consistent conditions to be met prior to the approval of new outlets. For example, the policy states that the NCC shall:

- encourage and support interjurisdictional watershed planning initiatives to resolve stormwater management issues;
- encourage and favour source control of stormwater, and practices and designs that make use of natural filtration and infiltration processes; and
- ensure that the quantity and quality of stormwater runoff are compatible with federal, provincial and municipal standards applicable to the region.

By implementing this policy, the cumulative effects of stormwater discharge into the rivers are reduced to an acceptable level and the environmental assessments for new outlets can focus on site-specific issues.

CASE STUDY
Parks Canada: Trent-Severn Waterway

The Trent-Severn Waterway is a navigable system of lakes, rivers and artificial channels managed by Parks Canada for the preservation and interpretation of natural and cultural heritage resources. Currently, over 500 stormwater outlets discharge into the waterway. In 1997 managers of the Trent-Severn Waterway considered mandatcry licensing of all stormwater outlets. Under the *Canadian Environmental Assessment Act*, each license would trigger an environmental assessment. This provided a test case for Parks Canada's approach to CEA. Outlets discharging into the Peterborough Reach section of the Waterway were grouped into a collective assessment using the following approach:

1. A scoping workshop focused the assessment on the cumulative effects of total phosphorus (which was known to be problematic) and E. coli bacteria (which provided an indicator of pathogens in the waterway).
2. An analysis based on sources, pathways of accumulation and consequences was then undertaken (CGS 1997). All existing stormwater outlets were mapped and the nature of the surrounding drainage areas was characterized.
3. The analysis determined that downstream water quality was not significantly affected by the bacterial content of stormwater outlet discharge. However, outlets in the vicinity of beaches needed special attention because of the cumulative effects on recreational activities.
4. The cumulative phosphorus load was determined to be of concern in the Peterborough Reach, but the urban stormwater contribution to this load was calculated to be approximately 0.7%. Since mitigation for existing outlets is expensive, the assessment recommended that greater benefits might be achieved at lower costs by a reduction of equivalent loads elsewhere in the system (i.e.; a phosphorous trading program).
5. Other recommendations focused on the encouragement of best management practices for new stormwater outlets and the adoption of a co-operative approach with federal departments, provincial agencies and municipalities. It was also recommended that a similar assessment be undertaken along the entire waterway.

CASE STUDY
Natural Resources Canada: Matrix-Based Screening

Natural Resources Canada uses two matrices to assist screeners in completing the Environmental Assessment Report for a project (NRCan 1996). The first matrix requires the screener to identify if any aspect of the action causes any of 40 types of biophysical effects (e.g., surface water temperature, erosion, breeding disturbance) and any of 12 social-cultural-economic effects. Space is provided for the assessor to include any other applicable effects. The second matrix identifies the potential effects of 26 other common types of actions (e.g., agriculture, mining, solid waste disposal), and provides space to add others. It requires the assessor to identify which other actions are present in the study area, and then which of their effects may combine with those of the project, as identified in the first matrix. In the report, the assessor must then indicate if any of the potential effects are likely, consider mitigation for likely effects, and determine whether the residual effects are significant.

CASE STUDY
Yukon DIAND: A Multi-Form-Based Approach to Screening

The Department of Indian Affairs and Northern Development (DIAND) in the Yukon is responsible for reviewing and issuing hundreds of permits and licenses each year for many types of actions. The department follows a two-level screening process: Level 1 for relatively small actions with known mitigation, and Level 2 for the fewer actions with known concerns and requiring more detailed review. A Level 1 screening may be "bumped up" to Level 2 if effects are suspected or known to be significant.

A Form-based approach to screening was proposed (DIAND 1997) to ensure that screening could be accomplished in an efficient and timely manner within the agency resources available, while ensuring that any substantive issues of concern receive further review. Each step has a Form (i.e., a "fill in the blanks" table or checklist) that guides the assessor through that step. Forms are linked so that all or some of the results of each Form provide input to decisions made in the next.

The screening process consisted of two parts: 1) Referral Information Request; and 2) Effects Screening. In Part 1, emphasis was placed on first collecting as much information as possible, both from external agencies, other internal departments, public stakeholders, and the knowledge of the screener. In Part 2, emphasis was placed on first determining if there were any significant local effects, justifying further assessment to determine the potential for cumulative effects.

The following summarizes the proposed steps for Level 1 screening:

Part 1: Referral Information Request

1. ***Identification of Valued Ecosystem and Cultural Components*** (VECCs): Identify VECCs and justify their selection.[27]
2. ***Identification of Temporal Boundaries***: Identify in which months VECCs occur in the vicinity of the action, and in which months an action may cause an effect to those VECCs.
3. ***Identification of Local Effects and their Mitigation***: For each type of effect, identify the VECCs affected and if the effects are mitigable, describe the mitigation applied, and rank the mitigation success (i.e., none, partial or complete).
4. ***Identification of Regional Issues***: Identify if any special features or "hotspots" (e.g., nearby protected areas, critical habitat, unique landscape features, rare/endangered species, heavily disturbed areas) may be affected, if thresholds are available for various environmental components, and if any regional land use management initiatives are available (e.g., forest harvest plans, wildlife hunting unit objectives).

(cont . . .)

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[27] The term "VECC" combines the terms "VEC" and Valued Social Component (VSC).

5. ***Select an Appropriate Spatial Boundary***: If no other approach exists to identify a boundary, this Form is used as an alternative. For each of seven types of actions, a boundary based on the nearest similar interacting feature or a distance in kilometres (from 5 to 20) is suggested for each of nine environmental components. This boundary is used to select other actions.
6. ***Action Inclusion List***: List the various actions that fall within the spatial boundary and identify if the action is past, current or future.
7. ***Identify Regional Cumulative Effects and their Mitigation***: For various types of cumulative effects (the same as identified in Form 10), identify the VECCs that may be affected, if the effects are mitigable, describe the mitigation, and identify the probable success of mitigation.
8. ***Identify Sources of Baseline Information***: Identify information describing each VECC, particularly if any maps are available to characterize them.

Part 2: Effects Screening

9. ***Screening of Local Effects***: For each VECC, rank the strength of the interaction between the VECC and various action components (i.e., Low, Moderate or High) and rank the significance of the interaction. Tables that define the rankings for various conditions are provided.
10. ***Screening of Cumulative Effects***: For each VECC identified in Form 9 as being significant (i.e., rank of M or H), rank the degree of temporal and spatial overlap and significance of the cumulative effect on that VECC for three main types of cumulative effects (see below for an example, partially completed for a timber permit application). Tables that define the rankings for various conditions are provided for the screener.

Form 10: Screening of Cumulative Effects

Type of Cumulative Effect	VECCs	Other Projects/Activities*				
		other cutblocks	highway and roads	nearby community	traplines	recreation site
Physical-chemical Transport						
Chemical contaminants						
Physical constituents						
Landscape Nibbling						
Direct habitat loss	woodland caribou (11)	L/L	M/L (12)	L/L	M/L (13)	L/L
	american martin (11)	L/L	M/L	L/L	M/L	L/L
Habitat fragmentation	woodland caribou	L/L (14)	M/M (15)	M/L (16)	M/L (16)	M/L (16)
	american martin (17)	L/L	L/L	L/L	L/L	L/L
Blockage of wildlife movements						
Direct-mortality of wildlife						
Socio-economic						
Changes to community services and quality of life						
Economic redistribution						
Alteration of traditional/ cultural activities						

* Rankings are degree of overlap followed by significance (e.g., M/L).
Numbers in brackets; e.g., (11), indicate a cross-reference to a decision record.

4.2 REGIONAL PLANNING AND LAND USE STUDIES

CEAs are usually done as part of a single project application submitted to regulatory agencies for approval.[28] Effects from the one project are then the focus of the assessment, although CEA approaches also require consideration of effects from other actions. In some cases, however, cumulative effects approaches are used as an integral part of what is commonly referred to as a regional planning or land use study. These are usually initiated because of rising concerns about the effects of many proposed developments in a certain geographic region. It is also possible that a proposal for a single, usually large project, may alone raise concerns to trigger such a study. Although such studies may ultimately provide the best and most complete assessment of cumulative effects, such initiatives are not as common and are not a legislated requirement as are single-project assessments required under environmental assessment Acts.

Such studies are usually not the responsibility of a single proponent, but of a number of government agencies and stakeholders (which may include several proponents of various actions in the region). Increasingly, multi-stakeholder involvement is the approach being used to accomplish such studies (e.g., as used in the Athabasca Oil Sands CEA Framework Study in Alberta and for Natural Area Conservation Plans in northern Canada).

Although these regional studies share some elements of project-specific CEA, they may also:

- involve larger spatial boundaries;
- take many years to complete, often due to the considerable amount of data collection and analysis required;
- occur *before* many actions begin in a region as opposed to *after* an action is first proposed (i.e., they are proactive as opposed to reactive), in some cases to provide input to area management plans (such as for a park); and
- be used to establish acceptable thresholds of change, which can then be used for subsequent project-specific assessments in the same geographic region.

It is important to note that project-specific CEAs cannot be forced into the role of a regional planning study. Despite their apparent similarities, CEAs demand a greater level of technical detail and certainty in the analysis and the description and likelihood of other actions and environmental effects to meet the requirements of regulatory reviewers. An example of this is a project proposed for a relatively undisturbed region, such as a mine (i.e., the "first-in"). An assessment of that project's effects under regulatory review will be limited in predicting effects of other possible future actions if the nature of those actions remains quite unclear (i.e., what they may be and when they may proceed, if at all). It is not the responsibility of the mine's assessment to include an equivalent level of detailed analysis of effects from other possible future actions if there is not enough information about those actions to adequately characterize their impacts and effects. However, a planning study may gather what information is available, project trends into the future (accepting the uncertainties), and recommend conditions under which future project applications should be assessed and reviewed to ensure certain long-term land use objectives are met.

Regional Planning and Studies: Approaches

Regional Planning and Studies: Case Studies

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[28] This is not always the case in other jurisdictions. In New Zealand, for example, effects assessment and regional planning are integrated in both legislation and assessment practice.

Examples of Regional Planning and Land Use Studies

- Beaufort Regional Environmental Assessment and Monitoring Program (Beaufort Sea and Mackenzie Valley Delta/Valley, NWT)
- Banff-Bow Valley Study (Banff National Park, Alberta)
- Hudson Bay Program (Hudson Bay Region of Ontario and Quebec)
- Kluane National Park Reserve (Kluane National Park Reserve, Yukon)
- Moose River Basin (Ontario, south of Hudson Bay)
- Niagara Escarpment Plan Area (southern Ontario)
- Northern River Basins Study (northern Alberta, north-eastern BC and southern NWT)
- Oak Ridges Moraine Area Planning Study (southern Ontario)
- West Kitikmeot/Slave Study (NWT)

CASE STUDY
Oil Sands Projects in Northern Alberta: A Regional Study Approach

Extraction of heavy oil from bitumen sand deposits north of Fort McMurray, Alberta has occurred for many years; however, the latter part of the 1990s saw a sharp increase in the level of activity. A number of new projects were proposed along with expansions of existing projects. In response to growing concerns about the cumulative effects of these actions in the Fort McMurray region, and acknowledging the limitations of a project-by-project review process, various provincial and federal agencies called for a regional study approach to address these concerns.

For example, in its decision on Syncrude's Aurora Mine, the Alberta Energy and Utilities Board (AEUB 1997) stated that "the need for a comprehensive review of potential activity in the oil sands region of northern Alberta relates to both the environment and conservation of energy resources. Because the ore body is large and extends over lease boundaries and confluent waterways, cooperative development is imperative...Cooperation could result in substantial improvement to the post-mining landscape."

To some extent, the various proponents had arrived at the same conclusion, and had begun discussions on the topic of regional cumulative effects. Syncrude, for example, stated that "Each of the companies supports the orderly, efficient, and economical development of Alberta's oil sands resources. This is best accomplished by oil sands developers voluntarily exploring opportunities for cooperation which enhance economic return and mitigate any potentially adverse environmental, socio-economic and cultural impacts." (Syncrude 1997).

In response to the recognition of potential cumulative effects, the industry developed a framework whereby the effects of new facilities would be related to a baseline of existing regional effects. Shell Canada, for example, provided assessments (Shell 1998) of three development scenarios in it's Muskeg River Mine application to the AEUB, each indicating the effects of the project in combination with:

- existing developments;
- existing and approved developments; and
- existing and approved developments, plus publicly disclosed developments (this was termed the Regional Development Scenario).

As new proposals reach the application review stage, their incremental effects would be referenced to the regional review information compiled earlier. In all, 13 projects (including in-situ production proposals) were incorporated in the Regional Development Scenario.

Within each scenario the effects on a number of parameters were predicted for 14 components: air quality, hydrology, surface water quality, surface water hydrology, aquatic resources, ecological land classification, terrain and soils, terrestrial vegetation, wetlands, wildlife, human health, historical resources, resource use, and traditional land use.

CASE STUDY
Kluane National Park Reserve: Management Plan Update

A CEA was conducted of Kluane National Park Reserve (KNPR) in the south-western Yukon to provide input into revisions to the Park's Management Plan (Hegmann 1995). The intent was to evaluate the effects of multiple recreational and commercial activities on the park's ecosystem. A total of 86 actions, both inside and surrounding the park, were identified as actions possibly contributing to cumulative effects within the park.

Given the large number of actions, "disturbance nodes" were identified in the park, representing point (e.g., visitor interpretation centres) or linear (e.g., flight corridors and hiking trails) concentrations of various disturbances. The assessment focussed on effects on wildlife, principally large carnivores and ungulates. A series of steps were used to focus the assessment onto those interactions which had the highest risk of causing adverse effects on the VECs (e.g., grizzly bear, mountain goat). Zones of Influence and Disturbance Factors were quantified and used within a qualitative discussion of effects based on an Impact Model approach.

The CEA concluded by prioritizing the contribution of existing and proposed actions to overall cumulative effects in the park, thereby flagging actions of major concern for decision makers involved in the park's management.

CASE STUDY
Express Pipeline: Who is Responsible for Regional Planning?

Most of the proposed Express Pipeline would pass through two grassland ecoregions in an area currently undergoing extensive agricultural and oil and gas activity. The major cumulative effects issue raised by intervenors and addressed by the proponent and review Board was the regional loss and fragmentation of native prairie (Priddle *et al.* 1996). On these matters, the proponent submitted three main points:

- In the one case, where there was a probability of additive effect with another future action (the proposed nearby Wild Horse Pipeline would share some right-of-way), the period of time before recovery would remain small and effects localized. Hence, it was suggested that cumulative effects were not significant in that case.
- In a long-term historical context, the proposed action contributes only a small fraction of the total land use change given the large-scale conversion of native prairie to agriculture (some intervenors suggested that this emphasizes the need to ensure that future developments do not degrade the small amount of native prairie remaining).
- A project proponent does not have to complete a regional planning study to satisfy the requirements of the *Canadian Environmental Assessment Act*, but only must consider cumulative effects within the context of legislated EIA (Priddle *et al.* 1996). Such a study would extend the assessment scope significantly beyond what could be reasonably expected by a single proponent, especially as such regional planning initiatives did not yet exist (and, therefore, land use objectives and thresholds of change that could be used).

These arguments raised two important cumulative effects questions. First, whether a proponent can, in the absence of any upper limit or acceptable threshold of disturbance, be singly held accountable for the potential unacceptable loss of a VEC on a regional scale? Second, if mitigation (i.e., reclamation in this case) is not fully effective, is there the possibility that full recovery will never occur on a regional basis in highly sensitive areas (e.g., native prairie)?

CASE STUDY
New Zealand: CEA and Sustainable Development

In New Zealand, the progress towards institutional reform in support of regional approaches to CEA has probably gone further than in most places. A comprehensive reform of environmental legislation in the late 1980s led to the passing of the Resource Management Act 1991 (RMA). The RMA has an explicit requirement to consider cumulative effects in all decisions about resource allocation and use. What is also significant about this legislation is that environmental effects assessment is not established as a separate process from other planning decisions, but through the RMA effects assessment is established as an integral component of all decisions under the Act. At about the same time as the RMA was put in place, there was also a complete restructuring of local government, under which new territorial planning authorities (called regional councils) were established. Their geographic boundaries were defined according to major river catchments, in recognition of the fact that the primary responsibility of these councils is the management of resources and the environment. The RMA requires that these regional councils develop strategic resource management policies and plans and, in doing so, cumulative effects must be considered. These legislative changes, therefore, have given rise to an institutional system that demands a regional approach to resource management and policy, and in which CEA is an integral component.

What is also interesting about the New Zealand approach is that the central principle of the RMA is "sustainable management" of resources and the environment. This is significant, because it establishes the explicit requirement to address the management of resources and the environment according to a principle of sustainability. There is also the implicit connection made between CEA and sustainable resource management, because the assessment of cumulative effects is a requirement of all decisions under the legislation. The inference is that in order to manage resources on a sustainable basis, it is essential to consider the cumulative effects of decisions and that this is handled best within a strategic and regionally-oriented policy and planning context.

5.0 PREPARING AND COMPLETING A CEA

As there is no one clear approach to conducting a CEA, it is suggested that practitioners should follow the basic guidelines provided in this Guide, learn from the case studies provided, investigate specific techniques to address the issues of concern from other assessments and as described in the literature, and finally select an approach that best suits their assessment needs.

Preparing and Completing a CEA

Preparing to do a CEA

1. Discuss with the appropriate regulatory authority what its expectations are regarding the assessment of cumulative effects, and determine if it has any specific guidance on the content of the assessment.
2. Ensure that the Terms of Reference (if the proponent is involved in defining the terms) for the assessment adequately address the concerns of the regulatory authorities and key public stakeholders.
3. Prepare a complete description of the proposed action.
4. As early as possible, focus the assessment on only the most important issues and effects. Consult stakeholders. Admit that choices made now may later change as a result of new information.
5. Review, if available, assessments done for similar types of actions, ideally in a similar geographic area. This may provide valuable baseline data and information on suitable assessment approaches.
6. Review some of the literature on cumulative effects to familiarize yourself with the latest issues and techniques regarding CEA practice.

Using the Assessment Framework

7. Complete an assessment of the action's effects as normally done for an EIA (i.e., assess relatively local and direct effects on VECs caused by the action under review). This should generally follow the 5-EIA steps and the associated CEA tasks (➡ Section 3.1).
8. As you progress through the assessment, expand on the results and conclusions obtained for each step by examining each of the CEA tasks. This may be done during each step as the EIA progresses, or done after much of the EIA has been completed (the more common approach). Use the CEA tasks to form the basis of your CEA approach. Use the "CEA Checklist" (➡ Section 5.3) and "Key Criteria" (➡ Section 5.2) to ensure that you have considered the important attributes of a CEA.
9. Ensure that conclusions are defensible and the presentation of results can be readily interpreted and are usable by decision-makers.

Provided the assessment meets all legislated requirements, is technically and scientifically sound, addresses the key issues related to the action under review, and meets the minimum requirements expected of any CEA, it is of little importance which type of analysis is used. While doing this, practitioners may wish to consider the following:

- The ultimate objective of a CEA is to provide information to decision makers to allow them to make more informed decisions.
- Despite the challenges, assessing cumulative effects is possible and the approaches are improving as more experience is gained by practitioners and regulatory agencies.
- CEAs cannot do everything for everyone, and are only one step towards providing information on an action's effects and addressing the mitigation of those effects. Expectations as to what CEAs can accomplish must not exceed what can technically be accomplished,

what is scientifically known about environmental conditions, and what is possible within the existing regulatory review process and jurisdictional land administration.

- Cumulative effects methods *are* currently available for practitioners to conduct CEAs.
- There is not one comprehensive method by which any CEA may be performed; practitioners must select an appropriate method from a "toolbox" of approaches.
- Availability of good information may determine not only a practitioner's ability to do a CEA, but also the methods finally used to predict effects.
- The selected method must incorporate all of the relevant sources that may contribute to the effect being studied.
- CEAs cannot replace regional land use planning; however, CEAs may provide useful information for a land use planning process. Similarly, existing land use plans can be used to assist in completing project-specific CEAs.
- Mitigation recommendations in a CEA can be broader than may typically be proposed in a conventional EIA.
- As more assessments are conducted for various actions within a region, the amount of available data grows and precedent is set regarding best accepted practice.
- Despite the lack of regional thresholds and the current piece-meal fashion of *project-specific* assessment in addressing overall nibbling effects, the assessment of cumulative effects under regulatory review process currently represents an opportunity to address concerns of large-scale and long-term changes to the environment.

Where is the CEA Placed in the Submission?

There are at least four options for placing the CEA:

- within a separate "CEA chapter" after the EIA portion (this is the most common approach);
- as a stand-alone document, separately bound from the EIA report;
- integrated within the EIA as a unique sub-section, appearing at the end of each major section assessing effects on major environmental components (e.g., water, air, vegetation); or
- fully integrated with the EIA as regional issues are raised and examined.

The approach taken will depend on the practitioner's philosophy of cumulative effects (i.e., as inseparable from the EIA or as a unique and different view) and on which approach is most readily accomplished given the division of labour used in assembling the assessment report.

Lessons Learned from the Case Studies

A review of the detailed case studies in this Guide (Appendix B) suggests the following lessons can be learned:

- Assessment of cumulative effects on some components is relatively straightforward if quantitative tools and thresholds are available (e.g., for regulated constituents of air and water).
- Qualitative conclusions and ranking systems are useful to communicate results if supported by defensible quantitative analysis.
- Incremental changes caused by the action under review should be measured relative to an established baseline condition.
- Assess effects during "snapshot" points in time.

(cont . . .)

- Perform an assessment from the point of view of effects on VECs as opposed to interactions between actions.
- Interactions do not need to be assessed individually; characterize the entire surrounding environment as it "appears" to each VEC.
- Other past and existing actions often become part of the background environment for a VEC.
- Lack of information regarding other actions may limit the assessment of their contribution to effects. As many disturbances are temporary, effects often recover within an acceptable period of time.
- Induced activities (e.g., road proliferation) may be an important cause of effects.

5.1 EFFECTIVELY COMMUNICATING RESULTS TO DECISION MAKERS

Environmental assessments are fundamentally the gathering of information, their analysis and presentation of the results. A CEA is one of many tools that may be used to assist decision-makers in their deliberations about project applications, resource management plans and conservation goals. As CEAs may deal with relatively complex issues, the practitioner's challenge is to ensure that the methodological approach and assessment results can be readily interpreted and weighed by decision-makers (e.g., practitioners often use visualization tools such as maps and network diagrams to distill order from apparent chaos and to communicate results to decision-makers).

Decision-makers require sufficient information to allow them to make justifiable and confident decisions as they weigh the environmental effects against social and economic benefits and costs.[29] They also wish to ensure that the legal requirements for the CEA are met. Therefore, assessment practitioners must clearly communicate the results of the assessments to decision-makers so as to best facilitate their deliberation on project approval. Repetitive use of tables of numbers and maps (especially if inadequately explained) are no substitute for a concise and readily defensible conclusions based on the data and analysis applied in the assessment.

One of the most important responsibilities of decision-makers is to determine whether the proposed project ought to be allowed to proceed and, if so, under what conditions. To facilitate this decision, it is essential that the CEA should contain, explicitly, a summary of management options and their consequences. These would include matters such as the mitigation measures to be employed, any compensation programs and follow-up studies (monitoring and management programs) to be conducted. Moreover, it is also important to explain why each of these management features is proposed, by whom it would be carried out and the level of commitment to each task by those responsible.

To effectively communicate the results of the CEA, the practitioner should consider use of the following techniques:

Discussion: The discussion should be a description of the analysis and interpretation of the results. Discussion based on professional judgment should be clearly distinguished from that based on a specific form of analysis and data. Assumptions, limitations and degree of confidence (i.e., certainty) placed on the data and analysis should be explained. Full scientific references should be provided for literature and personal communications.

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[29] Decision-makers, such as Review Boards, often must make decisions on project approval based on issues other than those dealt with in an environmental assessment. One example, with cumulative effects implications, is that the development of a project may foreclose the opportunity for future projects (of the same or different types) to occur in the vicinity of that proposed project (e.g., a pulp mill is approved on condition that it has guaranteed harvesting access to a large forested area surrounding the mill). In deliberating on the approval of such a project, the value of projects prevented from occurring, or occurring at a reduced level, may be considered. As a result, regulatory bodies may push for more stringent mitigation measures or intensive monitoring of project operations. Another example of decision-makers pursuing other matters is when they consider effects and issues beyond those strictly required to meet the conditions of a permit or license application (e.g., triggers from the Law List under the *Canadian Environmental Assessment Act*).

Decision Record: A decision record[30] should be included in the assessment, usually as an Appendix, to provide further clarification and expand on specific points of discussion.

Tables: Tables should be used to organize data and summarize the results of calculations.

Matrices: A matrix (a table in which the table entries are rankings) can be used to summarize the scale of effects (➡ Section 3.2.5.1). These rankings can take three different forms: 1) qualitative (e.g., low and high), 2) quantitative (i.e., numbers that correspond to an absolute physical quantity), or 3) indices (i.e., non-dimensional numbers that provide a point of relative comparison).

Images: Figures should be used as extensively as possible to illustrate the information. Maps, especially those derived from a GIS, are powerful tools for portraying disturbance and environmental conditions over a wide region. Photographs, photomontages and video also help to provide a visual orientation.

5.2 KEY CRITERIA FOR CEA

The following proposes criteria that establish the expectations of best professional practice in completing a CEA.

Key Criteria for an Acceptable CEA

1. The study area is large enough to allow the assessment of VECs that may be affected by the action being assessed. This may result in an area that is considerably larger than the action's footprint. Each VEC may have a different study area.
2. Other actions that have occurred, exist or may yet occur that may also affect those same VECs are identified. Future actions that are approved within the study area must be considered; officially announced and reasonably foreseeable actions should be considered if they may affect those VECs and there is enough information about them to assess their effects. Some of these actions may be outside the study area if their influence extends for considerable distances and length of time.
3. The incremental *additive* effects of the proposed action on the VECs are assessed. If the nature of the effects interaction is more complex (e.g., synergistic), then the effect is assessed on that basis, or why that is not reasonable or possible is explained.
4. The total effect of the proposed action and other actions on the VECs are assessed.
5. These total effects are compared to thresholds or policies, if available, and the implications to the VECs are assessed.
6. The analysis of these effects use quantitative techniques, if available, based on best available data. This should be enhanced by qualitative discussion based on best professional judgement.
7. Mitigation, monitoring and effects management are recommended (e.g., as part of an Environmental Protection Plan). These measures may be required at a regional scale (possibly requiring the involvement of other stakeholders) to address broader concerns regarding effects on VECs.
8. The significance of residual effects are clearly stated and defended.

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[30] This is not to be confused with the *Decision Report*, issued by regulatory agencies, that explains the decision reached regarding a project application.

5.3 CEA CHECKLIST

Answering the following questions (many during scoping) should ensure that the assessment incorporates important attributes of a CEA.

Local Effects

☑ Does the assessment of local effects (i.e., in the EIA) indicate a likelihood of other than negligible residual effects? If so, on which VECs?

☑ Is the proposed action within a relatively undisturbed landscape, or a landscape already disturbed?

☑ Do topographic or other constraints spatially limit the effect that the action may have on VECs?

Other Actions

☑ Is there any evidence that the effects of past actions may still be other than negligible?

☑ Are the nearest existing actions to the proposed action possibly contributing to effects on the same VECs?

☑ Have any actions been officially announced by other proponents with the intent to begin submission under statutory requirements?

Regional Issues

☑ Have any issues or VECs already been identified in the EIA or by local stakeholders that may be of concern beyond the footprint of the proposed action?

☑ Are any VEC species locally or regionally rare? Are there any environmentally sensitive areas that may be disturbed?

☑ With or without local significant effects, could the action contribute to regional "nibbling" loss of habitat (terrestrial or aquatic) that may affect VECs that reside or pass through the action's local study area?

Assessment

☑ Is the assessment focussed on effects on VECs to which the action under review may contribute?

☑ Is there reliable information (both science and traditional-knowledge based) that describes the VECs and the habitat on which some VECs depend?

☑ Is there adequate information available about other actions to confidently determine if they are contributing to other than negligible effects on the same VECs?

☑ Are indicators available to assess VECs?

☑ Are there indicators of significance other than thresholds that should be considered?

☑ Could the action induce other actions to occur (especially road access)?

☑ Can a historical baseline be described against which consecutive changes can be compared?

☑ Are any effects traceable back to the action under review? Is the action responsible for incrementally contributing to the effect?

☑ Are certain analytical approaches mandatory for assessing effects on some VECs?

Signifi[illegible]

☑ Are quantitative thresholds available for any of the VECs? Are qualitative thresholds available that describe intended land use (e.g., land use plans)?

☑ If landscape indicators are proposed, can the derived values be used to determine if the effects on a VEC have exceeded or may exceed the VEC's ability to recover?

Mitigation

☑ Is the standard or a novel application of mitigation adequate to mitigate significant effects?

☑ Can reclamation reduce the duration of land disturbance and hasten the recovery of environmental components to pre-disturbance conditions?

☑ Is habitat of equivalent capability available elsewhere to compensate for lost habitat?

☑ Is there an opportunity to initiate a regional level mitigation (or compensation) of effects?

☑ What is required for monitoring and effects management as follow-up?

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A GLOSSARY

Action: Any project or activity of human origin.

Activity: Any action that is not a physical work. Activities do not involve the construction of an object and may lead to an environmental effect (e.g., a highway is a physical work, but traffic on the highway is an activity).

Assessment Framework: A description of a process that organizes actions and ideas, usually in a step-by-step fashion. Frameworks help to guide practitioners in carrying out an assessment.

Baseline Information: A description of existing environmental, social and economic conditions at and surrounding an action.

Cause-effect Relationship: The connection between an action's disturbance (cause) and its effect on the environment.

Combined Effects: The effects caused by various components of the same action.

Connectivity: A landscape feature that facilitates the movement of biota between blocks of habitat (i.e., in a fragmented landscape).

Cumulative Effects Assessment: An assessment of the incremental effects of an action on the environment when the effects are combined with those from other past, existing and future actions.

Decision Record: A description of various aspects of an assessment, such as what assumptions were made, uncertainties in the data or analysis, and confidence in the reliability of the data.

Direct effect: An effect in which the cause-effect relationship has no intermediary effects.

Direction: The degree to which an effect on a valued environmental component will worsen or improve as the action proceeds (i.e., adverse, beneficial or neutral).

Duration: The period of time in which an effect on a valued ecosystem component may exist or remain detectable (i.e., the recovery time for a resource, species or human use).

Effect: Any response by an environmental or social component to an action's impact. Under the *Canadian Environmental Assessment Act*, "environmental effect" means, in respect of a project, "(a) any change that the project may cause in the environment, including any effect of any such change on health and socio-economic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by aboriginal persons, or on any structure, site or thing that is of historical, archaeological, paleontological or architectural significance and (b) any change to the project that may be caused by the environment, whether any such change occurs within or outside of Canada".

Environmental Components: Fundamental elements of the natural and human environment. Examples of components include: social, air, water, soils, terrain, vegetation, wildlife, fish, avifauna and land use.

Environmental Protection Plan: A description of what will be done to minimize effects before, during and after project construction and operation. This includes protection of the environment and mitigation of effects from project activities.

Evaluation: The determination of the significance of effects. Evaluation involves making judgements as to the value of what is being affected and the risk that the effect will occur and be unacceptable.

Focusing: *See Scoping.*

Footprint: *See Project Footprint.*

Fragmentation: The breaking up of contiguous blocks of habitat into increasingly smaller blocks as a result of direct loss and/or sensory disturbance (i.e., habitat alienation). Eventually, remaining blocks may be too small to provide usable or effective habitat for a species.

Frequency: The number of occurrences of an event within a specific period of time.

Impact: any aspect of an action that may cause an effect; for example, land clearing during construction is an impact, while a possible effect is loss and fragmentation of wildlife habitat.

Impact Attribute: Features of an effect (e.g., magnitude, scope, duration, frequency, direction, likelihood, significance) that assist in evaluating the nature and significance of the effect.

Impact Model: A formal description of a cause-effect relationship that allows the assessing of various components of that relationship through the use of an Impact Statement, a Pathways Diagram, and the validation of linkages and pathways.

Impact Statement: The description of a suspected cause-effect relationship through the use of a formal scientific hypothesis.

Indicators: Anything that is used to measure the condition of something of interest. Indicators are often used as variables in the modelling of changes in complex environmental systems.

Indirect effect: An effect in which the cause-effect relationship (e.g., between the project's impacts and the ultimate effect on a VEC) has intermediary effects. As an interaction with another action's effects is required to have a cumulative effect (hence, creating intermediary effects), cumulative effects may be considered as indirect.

Induced Action: An action that occurs as a consequence of another action. The induced action is not an intended component of the initiating action.

Interaction Coefficient: A numerical representation of the magnitude of interaction between an action and environmental components

Interaction Matrix: A table in which the cell elements are rankings.

Interactions: An action or influence resulting from the mutual relationship between two or more actions or an action and a VEC.

Issue: A subject of concern to anyone involved in the assessment or affected by the action. A concern usually has adverse implications to either the environment or people.

Likelihood: The degree of certainty of an event occurring. Likelihood can be stated as a probability.

Linkage: The relationship between a cause and effect in impact models. Linkages are illustrated in Pathway Diagrams as arrows between boxes.

Local Study Area: The spatial area within which local effects are assessed (i.e., within close proximity to the action where direct effects are anticipated).

Magnitude: A measure of how adverse or beneficial an effect may be.

Mitigation: A means of reducing the significance of adverse effects. Under CEAA, mitigation is "the elimination, reduction or control of the adverse environmental effects of the project, and includes restitution for any damage to the environment caused by such effects through replacement, restoration, compensation or any other means".

Monitoring: A continuing assessment of conditions at and surrounding the action. This determines if effects occur as predicted or if operations remain within acceptable limits, and if mitigation measures are as effective as predicted.

Network Diagram: An illustration of cause-effect relationships between an action's impact and an effect (also see "Pathway Diagram").

Non-trivial Effect: A high probability of occurrence or an unacceptable magnitude (i.e., significant) of an effect.

Pathway Diagram: A simple diagrammatic representation of a cause-effect relationship between two related states or actions that illustrates an impact model. Pathway diagrams take network diagrams one-step further by evaluating each linkage and assessing the cause-effect relationship in the context of a scientific hypothesis.

Pathway: A series of consecutive valid linkages in a Pathways Diagram.

Project: Any action or activity requiring the design, construction and operation of structures or equipment. Projects are usually defined with a specific name, function and description. Under the CEAA, a "project" means (s. 2(1)): "(a) in relation to a physical work, any proposed construction, operation, modification, decommissioning, abandonment or other undertaking in relation to that physical work, or (b) any proposed physical activity not relating to a physical work that is prescribed or is within a class of physical activities that is prescribed pursuant to regulations made under paragraph 59 (b)."

Project Footprint: The land or water area covered by a project. This includes direct physical coverage (i.e., the area on which the project physically stands) and direct effects (i.e., the disturbances that may directly emanate from the project, such as noise).

Qualitative Analysis: Analysis that is subjective (i.e., based on best professional judgement).

Quantitative Analysis: Analysis that uses environmental variables represented by numbers or ranges, often accomplished by numerical modelling or statistical analysis.

Reclamation: The alteration of a landscape, usually as mitigation for an action, to re-create conditions prior to the project.

Recovery: The return of environmental conditions to the state they were prior to the action.

Region: Any area in which it is suspected or known that effects due to the action under review may interact with effects from other actions. This area typically extends beyond the local study area; however, how far it extends will vary greatly depending on the nature of the cause-effect relationships involved.

Regional Planning and Land Use Study: An assessment of existing environmental and social conditions due to the combined influence of all actions, usually within a large geographic area. These studies differ from CEAs in that they are not focussed on only one project application, are often conducted prior to the review of future actions to assist in decisions on future applications, and may propose regional thresholds against which incremental changes may be compared for use in future project applications.

Regional Study Area: The spatial area within which cumulative effects are assessed (i.e., extending a distance from the project footprint in which both direct and indirect effects are anticipated to occur).

Residual Effects: Effects that remain after mitigation has been applied.

Scenario: A description of environmental and development conditions at a certain time to allow comparisons of change (e.g., pre-development, current, and reasonably foreseeable).

Scoping: A consultative process for identifying and possibly reducing the number of items (e.g., issues, VECs) to be examined until only the most important items remain for detailed assessment. Scoping ensures that assessment effort will not be expended in the examination of trivial effects.

Significance: A measure of how adverse or beneficial an effect may be on a VEC.

Spatial Boundary: The area examined in the assessment (i.e., study area).

Spatial Overlap: An overlap of zones of influence from different actions.

Study Area: The geographic limits within which an impact to a VEC is assessed.

Temporal Boundary: The period of time examined in the assessment.

Temporal Overlap: A period of time in which activities from different actions occur simultaneously.

Threshold: A limit of tolerance of a VEC to an effect, that if exceeded, results in an adverse response by that VEC.

Trivial Effect: A low probability of occurrence or acceptable magnitude (includes case of no effect) (i.e., insignificant).

Validation: A confirmation of the validity of an impact hypothesis, linkage or pathway.

Valued Ecosystem Component: Any part of the environment that is considered important by the proponent, public, scientists or government involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concern.

Zone of Influence: A geographic area, extending from an action, in which an effect is non-trivial.

B CEA CASE STUDIES

This Appendix describes 12 CEA case studies.[31] Each case study is in the form of a narrative which describes a project and the approach that was used to address cumulative effects issues in the project's assessment. Each case study is prefaced by a brief description of the VECs, the major issues, the principle methodological approach, and the major lessons that can be learned from their review. Key attributes of each case study are summarized in Table C1.

The purpose of the case studies is to demonstrate approaches used in addressing various project types and environmental concerns. The case studies (all from Canada) were selected based on familiarity of the CEA Working Group members with the projects. Review of these case studies provides an indication of what has been done in response to legislative requirements and, therefore, serve as a benchmark for future assessments. The case studies are not judged as to their quality, and it is not implied that what was done was necessarily state-of-the-art.

It is hoped that the reader can learn by example, and build on these examples with the guidelines provided in this Guide towards the goal of continually improving assessment practice into the future.

Practitioners should note that different projects create a unique set of effects and interactions among relevant VECs. Practitioners should therefore take care in adopting without modification any of the approaches described unless they are sure that it is appropriate for assessing conditions for their case at hand.

Case Studies (for references cited in this Appendix)

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[31] Some of these have appeared earlier in the Case Study Information Boxes. For these, this Appendix provides additional background information that should help to better place the study in context. Five case studies (Express Pipeline, Alliance Pipeline, Steepbank Mine, West Castle Valley Resort and Kluane National Park Reserve) are not described here in detail, and only appear as information boxes in Chapters 2, 3 and 4.

Table C1: Summary of Detailed Case Studies in Appendix B

Project	Example of...	Type of Project	Type of Review	Year EIA Initiated	Major VECs	Location	Level of Review	Statutory Requirements
Alberta-Pacific Pulp Mill	Assessing long-range aquatic transport of contaminants	Industrial Process	PH	1989	Water	AB	Joint*	EARP/AEP
Northern Saskatchewan Uranium Mines	Use of Pathway Models to assess effects of radionuclides	Mine (underground)	PH	1991	All	Sask.	Joint	EARP/Sask.
Cold Lake Oil Sands Project	Focused Impact Assessment and Impact Models	In-situ heavy oil	PH	1996	Water	AB	Prov.	AEP
Cheviot Coal Mine	Use of GIS to assess effects on wildlife	Mine (Open-pit coal)	PH	1996	Wildlife, water	AB	Joint	CEAA/AEP
Huckleberry Copper Mine	Assessment of a mine using a Project Committee approach	Mine (open pit base metal)	PH	1994	Water, fish	BC	Joint	CEAA/BC EAA
Terra Nova Off-Shore Petroleum Project	Assessing effects in a marine environment	Off-shore Petroleum	PH	1996	Water, fish	Nfld.	Joint	CEAA
Eagle Terrace Subdivision	Use of GIS to assess effects on wildlife	Residential development	PH	1996	Wildlife	AB	Town	Municipal
Trans-Canada Highway Twinning Phase IIIA	Assessment in a National Park	Highway	PH	1994	Wildlife	AB	Federal	EARP
Transportation Corridors (Glacier and Banff NPs)	Visual Impact Assessment	Highway, Railway	PH	1979	Visual	BC	Federal	EARP
Keenleyside Power Project	Assessment of a hydroelectric dam using a workshop approach	Hydroelectric dam	SC	1997	Water, fish	BC	Joint	CEAA/BC EAA
La Mauricie National Park Hiking Trail	Use of a screening level approach	Recreational trail	SC	1996	Wildlife	Quebec	Federal	CEAA
Mineral Exploration in the Northwest Territories	Consideration of effects of remote exploration activities	Mineral Exploration	SC	1996	Wildlife, hunting	NWT	Territ.	EIRB/IFA

*: i.e.; federal/provincial

Acronyms

Type of Review: PH=Public Hearing, SC=Screening Level Review

Statutory Requirements: AEP Alberta Environmental Protection, CEAA Canadian Environmental Assessment Act, EARP Environmental Assessment and Review Process, EIRB Environmental Impact Review Board, IFA Inuvialuit Final Agreement, BC EAA British Columbia Environmental Assessment Act

ALBERTA-PACIFIC PULP MILL

Case Study Highlights

VECs: Water quality, aquatic organisms

Issues: Reduced concentration of dissolved oxygen, discharge of chlorinated organic compounds

Approaches: Dissolved oxygen-biological oxygen demand and dioxin transport simulation models

Lessons learned: Addressing effects in large watersheds can be accomplished by mitigation at source and long-term monitoring

Background

The Alberta-Pacific (Al-Pac) Pulp Mill is a bleached kraft pulp mill that was proposed for north-central Alberta. As the assessment was completed prior to the enactment of the *Canadian Environmental Assessment Act*, cumulative effects were not examined in the submitted EIA. However, the Terms of Reference for the joint federal-provincial review Board included the requirement to examine cumulative effects in the Peace Athabasca river system, a watershed that encompasses parts of British Columbia, Alberta and the Northwest Territories (DeSorcy *et al.* 1990). Contamination of fish along the river system was suspected to occur a considerable distance (i.e., in the order of hundreds of kilometres) downstream of existing mills.

Assessment Approach

Two major aquatic concerns arose: dissolved oxygen concentrations and persistence of chlorinated organic compounds.[32] For the first of these (oxygen), the Alberta government, apparently in anticipation of pulp mill developments, had recently completed a study of dissolved oxygen (DO) and biological oxygen demand (BOD). All significant contributors to BOD loading on the rivers were pulp mills (the communities on these rivers were all small), and their BOD loads were regulated. The information was public, which overcame the problem of Al-Pac requesting possibly proprietary information from the other mills (i.e., its competitors). A DO-BOD simulation model, calibrated to the river system, was used to assess effects. Although participants in the review argued otherwise, the Board found the model to be credible and acceptable for predicting DO in the rivers.

The assessment of effects due to chlorinated organic compounds was more difficult. The recent discovery that these pulp mills produced dioxins and furans (albeit at very small amounts) and the very high cost of analysis for such compounds in fish (at such low concentrations) meant that available data was inadequate to conduct a proper assessment. To address this deficiency, the federal Department of Fisheries and Oceans, experts from the proponent and other individuals provided information on the cumulative effects of the various mills on the river system. A model was finally presented that alerted the Board to the potential impacts of the discharge of dioxins and furans from the Al-Pac Mill in combination with other existing and new mills planned for the region.

The results of these models influenced the Board's final recommendations to initiate a multi-agency sponsored Northern River Basins Study, coordinated by a Study Board representing various regional stakeholders with assistance from a Science Advisory Committee. Research programs were conducted to identify data gaps, to provide an environmental baseline database (e.g. on contaminant levels) and to develop aquatic models.

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[32] The Board's Terms of Reference specifically excluded one major concern raised by interveners: the effects of timber harvesting. Inclusion of such effects is arguably required if cumulative effects of the project were to be adequately assessed.

Lessons Learned

- One of the important features of the methods used was that all sources of BOD, dioxins and furans were considered (i.e., not just from the Al-Pac mill alone).
- Industry data were obtained by government agencies, not by the proponent. This simplified the data collection process.
- Assessment methods were developed by experts in their respective fields who knew how best to predict the specific effects. This reflects well on the scoping process used by the Board, which identified the most important issues and then allowed those who were most knowledgeable to devise the appropriate studies.
- Uncertainty about the nature of the long-term response of the waterways and biota to the contaminants contributed to the Board's final decision to recommend that the project not be approved, and that trans-boundary studies be conducted on contaminant fate and dose-exposure before a reassessment and future regional planning effort could be made.

NORTHERN SASKATCHEWAN URANIUM MINES

Case Study Highlights

VECs: Air quality, groundwater, surface water, vegetation, wildlife, human health

Issues: Exposure to radiation

Approaches: Network diagrams

Lessons learned: Acknowledgement of poor understanding of cause-effect relationships, need for long-term monitoring supported by many stakeholders

Background

A joint federal-provincial panel was formed in 1991 to review and assess the environmental effects of five uranium mining proposals in Northern Saskatchewan. Two additional proposals were added to its mandate in 1992 and 1994. An independent team of consultants were hired to help the panel foresee significant impacts that may arise from interactions among the projects (Ecologistic 1992), an initiative that took a more regional view than the project specific impacts examined in the three Environmental Impact Statements (EISs) originally submitted.

In its January, 1993 report (Lee *et al.* 1993a), the panel recommended approval for exploration at one mine (McArthur River). In its October, 1993 report (Lee *et al.* 1993b), the panel recommended: 1) conditional approval for an extension of an existing operation (Dominique-Janine, at the Cluff Lake operation); 2) a conditional approval of a new mine (McClean Lake), with one of the conditions being a five-year delay; 3) and rejection of a third proposal (Midwest Joint Venture) because the risks to the environment and human health were judged to outweigh the benefits. In its February, 1997 report (Lee *et al.* 1997a), the panel recommended conditional approval for the McArthur River mining proposal. Later in 1997 (Lee *et al.* 1997b), the panel recommended conditional approval for the Cigar Lake and Midwest proposals.

The McArthur River mining proposal uses a mill and tailings disposal site at an existing operation at Key Lake. The Cigar Lake and Midwest proposals will share a milling and tailings disposal site at McClean Lake. The custom milling and tailings proposals, whereby five mines share two mills and tailings disposal areas, are recognized to offer significant benefit by reducing the amount of land disturbance in northern Saskatchewan.

Assessment Approach

The study area for the assessment was half of the province. The principal cumulative effects issues identified were: transfer of radionuclides and stable heavy metals through the pathways of surface water, groundwater and vegetation; effects due to ingestion or inhalation by humans, wildlife and fish; and various socio-economic effects such as effects on public health and native lifestyles.

An Environmental Transfer Pathway model (i.e., network diagram) was used to assess cumulative effects (these diagrams convey some of the function of Pathway Diagrams as used in Impact Models). The model defined physical and chemical linkages or pathways that connected impacts to effects, and zones of influence that identified the areal extent of those linkages. The diagrams were useful as aids to illustrate complex linkages. Results were tabulated for various VECs, which included an assessment of the significance of effects (by areal extent, frequency and duration, and certainty in prediction) and the potential for significant cumulative effects. An effect was considered significant if it was regional in extent, long-term and if there was a degree of uncertainty in the prediction.

Recommendations by the panel for mitigation of cumulative effects included the monitoring of key biological components and processes, epidemiological studies on all Saskatchewan uranium miners (past, present and future), use of this data to predict future risks and mitigation measures, long-term monitoring of worker exposure to airborne dust and gas contaminants, phasing of proposals, and education and training of residents to ensure long-term employment and avoidance of a "boom-bust" cycle. Monitoring plans for each project were mandatory to fulfill the proponent's licensing requirements, which are reviewed annually by the Canadian Atomic Energy Control Board and Saskatchewan Environment.

The federal and provincial governments are cooperating on a cumulative effects monitoring program, and a site-specific and regional cumulative effects model has been developed

Lessons Learned

- The assessment attempted to clearly define an organizational and jurisdictional framework in which CEA could be conducted, responsibilities of the stakeholders plainly stated, and collaboration encouraged for the collection of data.
- The specialist's study identified various problems typically encountered in CEA, such as "limited knowledge about cause and effect relationships, jurisdictional conflicts and confusion, poor coordination and cooperation among institutions, and conflicting societal values and expectations of the environmental assessment process and the varied status of environmental laws and regulations enforced and implemented by various levels of government".

COLD LAKE OIL SANDS PROJECT

Case Study Highlights

VECs: Air quality, water quality, water quantity, fish, vegetation, moose, black bear, lynx, fisher

Issues: Changes to air quality, changes to surface and groundwater water quality, decreases in surface water levels, loss of wildlife habitat, reduced opportunities for fishing and other resource harvesting, increased road access

Approaches: Focussed Environmental Assessment Process provided an overall framework; Impact Models provided a structured methodological approach; quantitative GIS-based or other modelling provided numerical analysis; qualitative discussion based on quantitative results and professional judgment

Lessons learned: Advantages of blending EIA and CEA approaches, benefits of Impact Model approach; difficulties in obtaining information about other projects

Background

Imperial Oil Resources Limited (Imperial Oil) proposed to expand its operations within its Cold Lake lease in north-central Alberta (IORL 1997a). This oil sands in-situ development, known as the Cold Lake Expansion Project, will expand the existing Cold Lake operations by the development of a central plant and addition of wells. Production is expected to increase from approximately 14,900 m^3/d to more than 20,000 m^3/d within a few years of operation. Approximately 2500 wells are currently operating within the Cold Lake Development Area.

The Cold Lake facility, the second largest producer of oil in Canada, extracts oil from sand deposits containing bitumen (a heavy oil). These deposits are located more than 400 m below the earth's surface, too deep for recovery by surface (open-pit) mining. Imperial Oil therefore developed cyclic steam stimulation, a thermal recovery process that injects steam at high pressure and temperature into the bitumen reservoir. The process consists of three steps (steaming, soaking and production) that is repeated until depletion of the bitumen reservoir.

Many pads, each containing a cluster of vertical and directional drilled wells (approximately 20 to 30) are used to access the bitumen-producing reservoir. Above-ground pipelines serve multiple pads, delivering steam to the pads and returning produced fluids to the central plant.

Assessment Approach

Imperial Oil was required to submit an EIA according to the Terms of Reference issued by Alberta Environmental Protection. The EIA was to identify direct project effects and cumulative regional impacts of the project. The objectives of the CEA component were to evaluate project-specific impacts in a regional context, taking into consideration other activities and projects that currently exist in the project region or projects that are reasonably foreseeable (i.e., have been approved, or are under approval). The Focused Environmental Assessment Process (Kennedy and Ross 1992) formed the basis of both the EIA and CEA. This approach included the use of a series of three workshops (issues scoping, assessment and mitigation) that provided a forum for practitioners to address various assessment issues. The Process also made use of Impact Models to describe important cause-effect relationships between the project and its surrounding environment.

Boundaries

Nine major environmental resource components were examined: air systems, surface water quantity, surface water quality, groundwater, aquatic resources, soils and terrain, vegetation, wildlife and resource use. A unique local and regional study area was identified for each component. In some cases, areas were the same for more than one component. Generally, the

CEA's spatial bounds were based on existing jurisdictional boundaries or boundaries of the watershed surrounding the project. Effects were examined at local, combined (i.e., all project components) and regional scales.

Three temporal bounds were identified: 1) "Past" to represent regional conditions (i.e., pre-1979) prior to the proposed major heavy-oil development in the region; 2) "Existing" that included Imperial Oil's current operations and other existing projects in the region (e.g., other oil sands projects, forestry); and 3) "Reasonably Foreseeable" that included all future projects with regulatory approval or that were under an approval process.

Analysis

Project effects were assessed at two scales: 1) combined effects of various activities directly associated with the project such as the pads, roads, and processing facilities; and 2) cumulative regional effects of the project with all other existing and reasonably foreseeable projects beyond the proposed expansion area (IORL 1997b).

The CEA relied on the results from a total of 35 Impact Models completed in the EIA (IORL 1997b). The models assessed effects on each of the nine environmental components. These models generally dealt with local effects; however, some models had regional implications "built-in" due to the wide extent of the effects. In these cases, conclusions reached from the models served as the basis for further assessment at a regional scale in the CEA (which consisted of a chapter in one of the volumes of the application submission). For some of these, the Impact Model itself constituted a substantial portion of the assessment approach for cumulative effects. Due to the close cause-effect relationships between different environmental components (e.g., water quality and aquatic resources), many Impact Models were "linked" together so that the output (i.e., results) from one model provided input into another.

The assessment of cumulative effects involved various degrees of quantitative (i.e., numerical) analysis and qualitative discussion. Qualitative analysis was conducted if a quantitative technique was not available or if a qualitative discussion was adequate. In all cases, interactions with various other projects were considered if the results of the Impact Models indicated a possibility of other than local effects. Temporal development scenarios were explicitly used in the assessment of effects on wildlife (the table "Summary of CEA Approaches" summarizes approaches used for each environmental component).

Lessons Learned

- The use of a consistent assessment approach (i.e., Focussed Environmental Assessment) was beneficial, as the assessors found the CEA to be simply an extension of results from the EIA. Also, use of the same environmental components in the EIA and CEA and consistent approaches for determining impact areas and significance improved the communication of assessment results for decision-makers.
- The identification and characterization of other projects in the CEA regional study area presented some challenges, partially overcome by including only projects with regulatory approval or under regulatory review.
- The use of threshold values for environmental components presented challenges. For the physical components (i.e., air, water, soil) it was possible to use accepted guidelines and standards and, with appropriate assumptions, to simply extend values to the regional scale. For biological components (i.e., aquatic resources, vegetation, wildlife) it was not as straight forward, as the implications of project effects were more complicated owing to synergistic effects and to effects that are not scientifically understood or easily interpreted.

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Summary of CEA Approaches

Environmental Component	CEA Approach
Air	Six Impact Models were developed. NO_x and SO_2 concentrations were calculated with a numerical air quality model as required by Alberta Environmental Protection and compared to provincial air quality thresholds within the airshed surrounding the project.
Surface Water Quantity	Three Impact Models were developed. Water use volumes and project sources were compared with volumes from other projects.
Surface Water Quality	Four Impact Models were developed. Key water quality parameters as defined by provincial guidelines were assessed.
Groundwater	Three Impact Models were developed. Contributions to water withdrawals, effects on water balance, and effects on water quality were assessed.
Aquatic Resources	Two Impact Models were developed. Qualitative discussion was used based on results of water quality and quantity assessments, regional workforce changes, and results of assessment of effects on various indicator fish species.
Soils and Terrain	Five Impact Models were developed. Cumulative effects were limited due to the very local nature of impacts and use of mitigation for provincial reclamation certification.
Vegetation	Three Impact Models were developed. The area of land cleared was quantitatively determined in a GIS for each of the 20 vegetation ecosites within the regional study area.
Wildlife	Four Impact Models were developed. Total habitat lost was quantitatively determined and implications on wildlife qualitatively discussed; changes in access density was quantitatively determined and implications on wildlife qualitatively discussed; changes in habitat suitability for four indicator species (moose, black bear, lynx and fisher) was quantitatively determined (with a GIS) and compared between three development scenarios.
Resource Use	Five Impact Models were developed. Qualitative discussion was used, based on results of impact models for all environmental components, focussing on implications of influences of regional "agents of change" (e.g., road proliferation, human population growth).

- The CEA for resource use is complex due to the often broad or subjective nature of the VECs. It was helpful to assign qualitative criteria for each resource use and provide detailed qualitative discussion based as much as possible on the baseline data and results from other Impact Models.
- The proponent was not in a position to reasonably address regional planning issues. Regional issues were discussed in the CEA with a recommended action plan for review by decision-makers (e.g., a regional scale environmental monitoring program).
- The integration of results from public consultation is a useful tool in determining relevant regional issues to be included in the CEA. It is important to ask questions about cumulative effects concerns during public consultation.
- The CEA's methodological approach included a judicious blend of quantitative and qualitative based assessment. In all cases, the Impact Models provided direction in the assessment for each environmental component. Professional judgement, as is typically the case in EIA practice, was often used to provide the final interpretation of the assessment results regarding overall regional and long-term implications on VECs. Extensive use of quantitative analysis (i.e., air models, water volumes, spatial changes to vegetation and habitat) considerably improved the final conclusions made by assessment practitioners.

CHEVIOT COAL MINE

Case Study Highlights

VECs: Elk, grizzly bear

Issues: Development near a large protected area (Jasper National Park), destruction of wildlife habitat

Approaches: GIS-based habitat modelling and the Cumulative Effects Model for grizzly bear

Lessons learned: Need for region based mitigation to ameliorate effects

Background

In 1996, Cardinal River Coal proposed a new coal development known as the Cheviot Mine Project (CRC 1996). The project included an open pit mine, processing plant, restoration of a rail line, and upgrading of an existing access road. This area is well known for coal mining and coal mining communities dating back to the early part of the century. Coal continues to play an important role in the local economy. The mine would be located east of Jasper National Park and south of the town of Hinton, Alberta. The mine permit area would extend approximately 23 km by 3.5 km, within which about 3000 ha would be disturbed. The mine would allow Cardinal River Coal to continue operations in the region, as their existing mine, a short distance north of the Cheviot site, was almost depleted.

Assessment Approach

The project originally required review as a comprehensive study and was later referred to a panel review. The timing of the panel review coincided with the provincial Alberta Energy and Utility Board's review, which permitted federal-provincial harmonization of the review process (the review process allows for harmonization under the *Alberta Environmental Protection and Enhancement Act* and the *Canadian Environmental Assessment Act)*. Cardinal River Coal prepared its EIA to follow the model applied in the Environmental Evaluation of Strait Crossing Inc.'s Northumberland Strait Project (the "PEI fixed link"). This methodology was considered practical, technically sound and was accepted by the Federal Court of Canada during its assessment.

The panel's public hearing occurred over six weeks. As might be expected in a development of this size, the issues of concern were many, spanning the social, economic, and environmental interests of the area, region and province. Particular attention was paid to the extensive alteration of fish habitat, habitat effects for certain wildlife species (specifically, grizzly bear and Harlequin duck) and reclamation in a sub-alpine setting.

The assessment identified VECs by addressing concerns of the public, government, and the professional community. VECs considered both biological and socio-economic attributes due to the broad-based definition of environmental effect as outlined both in federal and provincial legislation. While the *Canadian Environmental Assessment Act* offered some guidance regarding cumulative effects, relatively little was provided by the province.

The CEA examined effects on grizzly bear and elk, both "flagship" species in this area of Alberta's east slopes (CRC 1996b). GIS tools and models adapted to local knowledge and information were used to analyze effects. The modelling illustrated the effects of the mine on the regional movements and use of habitat by the species. Results indicated significant adverse negative changes in habitat use. Despite extensive quantitative analysis and time used for study, the professional judgement of biologists conducting the review was the primary basis for conclusions reached.

Effects on Elk

Cardinal River Coal conducted a three-step CEA using GIS-based overlays: 1) existing elk habitat was quantified; 2) the extent to which that habitat had already been modified by human activities was calculated; and 3) the incremental effect of the mine development was determined. The analysis was applied to an area of 900 km^2. Population viability was assessed using trend surveys and a population simulation model. A qualitative assessment was then made on the vitality of the population and the future trends in productivity and habitat effectiveness, which concluded that "at these levels…the remaining habitat should absorb the displacement of the current population until reclamation activities begin…".

Analysis indicated that the mine development would reduce regional winter and summer forage for elk by 3% and 2% respectively, and reduce cover by 8%. More habitat would also be lost due to alienation effects. The applicant concluded that initial impacts on elk would be negative as currently occupied habitat was lost, and re-establishment of annual movement and foraging patterns in adjacent habitat occurred. Once reclamation was initiated, the effect on elk should be lessened as quality forage becomes available at the edge of the mining disturbance.

Effects on Grizzly Bear

As carnivores requiring large home ranges are especially susceptible to the effects of human development, the grizzly bear was chosen as an indicator. The grizzly bear was also suitable because of its use as an "umbrella" species (i.e., indicates effects on a wide variety of other species, especially at lower trophic levels). Another reason for choosing grizzly bear was the existence of a scientifically accepted Cumulative Effects Model that quantitatively estimates individual and population effects of various land uses (USFS 1990). The model is composed of three modules: habitat, disturbance and mortality. The results were analyzed to predict habitat effectiveness and mortality risk, in which a 100% habitat effectiveness value (representing a disturbance coefficient of "1") means that grizzly bears were not deterred from using any of the available habitat due to human disturbance. Alternative land use scenarios could then be developed and evaluated relative to grizzly bear management objectives.

The analysis also included use of existing data on grizzly bear mortality, locations, and ecology; conducting of interviews with local residents knowledgeable about carnivores in the region; review of government fur harvest data; and collection and synthesis of data on regional populations of wolves and cougar.

The analysis predicted an immediate and significant adverse effect on grizzly bears in the Bear Management Unit surrounding the mine. The CEA concluded that regional pressures on large carnivores were reaching the point where "population losses will become serious and perhaps irreversible". Mitigation of these effects, even within a 100 year reclamation time frame, was considered difficult.

Given the prediction that grizzly would be significantly affected, Cardinal River Coal proposed that a "Carnivore Compensation Package" be created. A regional committee would clarify wildlife management objectives and develop plans for achieving them. The committee would be based on co-management among provincial, federal and regional levels of government, scientific experts, industrial stakeholders and citizen groups. Funding for regional level research would also be provided, managed and allocated by the committee. A similar cooperative approach was proposed for elk management, though a formal compensation committee was not specifically proposed.

Lessons Learned

- In conducting the CEA, it became obvious that many of the factors that could affect a VEC were not only as a result of activities associated with the proposed mine. Cardinal River Coal stated that [emphasis added]: "Because of administrative, ecological and technical boundary constraints, Cardinal River Coal acknowledges that it does not have the time, technical and economic resources to carry out cumulative effects studies for *all* anthropogenic sources or address *all* cumulative effects assessment factors which could influence *all* affected VECs. As a result the company elected to carry out cumulative effects studies only on selected VECs. Criteria for the selection of specific VEC cumulative effects studies were based either on professional opinion, public concern, or government interest in particular study disciplines."
- The applicant was also of the view that the responsibility for administration of land use activities, and the resulting cumulative effects assessment "lies ultimately with the regional resource planning agencies". Cardinal River Coal nonetheless conducted comprehensive data collection to obtain missing data within the administrative, ecological and technical constraints of the assessment.

HUCKLEBERRY COPPER MINE

Case Study Highlights

VECs: Water quality, air quality, wildlife and wetland habitat

Issues: Establishing the framework for a CEA

Approaches: Recognition of limited effects due to implementation of mandatory mitigation measures

Lessons learned: A nearby large project can overshadow the cumulative effects contribution of a proposed but relatively smaller project; local mitigation may be sufficiently adequate to ameliorate cumulative effects; geography can limit the spatial boundaries

Background

The Huckleberry Copper Mine is an open pit porphyry-copper mine located in central-west British Columbia. Access is by an 8 km extension of an existing upgraded forest service road or by air to a gravel airstrip constructed adjacent to the road. Power is supplied by a 115 km power line constructed along the road.

The company submitted a pre-application document in 1994 and applied for provincial approval under the *Mine Development Assessment Act* in 1995. With the proclamation of the B.C. *Environmental Assessment Act* in mid-1995, the provincial review was transitioned to the new review process. The project also required review as a Comprehensive Study under the *Canadian Environmental Assessment Act*. The principles of the Canada-B.C. Agreement for Environmental Assessment Cooperation (still under negotiation at the time) were followed in order to harmonize the federal and provincial environmental assessment requirements. The joint review was led by a Project Committee that included federal and provincial representatives. The report of the Project Committee (HCMPC 1995), which was released in late 1995, was used as the basis for the subsequent Comprehensive Study Report. The project was approved by both levels of government at the completion of the review.

Assessment Approach

Initially, there was some uncertainty in response to the federal Act's requirements to assess cumulative environmental effects. A subcommittee of federal and provincial officials was established to draft the assessment for the project committee. Their first action was to determine the nature and extent of potential interactions and then to identify projects with potential for cumulative impacts. Two types of regional effects were identified of possible concern: land use and mine discharges (mostly into water and dust into air). The site geography and small size of the project simplified the direct examination and detailed assessment of potential impacts and the identification of spatial boundaries. The temporal boundary was determined from regulatory requirements.

Land use issues were limited to incremental losses of forest and habitat for fish and wildlife. The severity of effects was minimized by the small mine footprint and use of the existing road and its right of way for locating the majority of the power and transportation infrastructure. The spread of air emissions were limited by the surrounding topography. The project's remote location and the limited spatial extent of effects also reduced the number of projects with the potential to interact with the mine. Two projects were identified that met the Act's definition for other projects: a proposal to recover submerged timber from the Kemano Reservoir, and current and proposed land-based forestry activities. Another concern was the effect that each of these may have on resource use by aboriginal and non-aboriginal communities.

Mine discharge was subject to regulated water quality levels, thereby substantially reducing the potential for downstream effects (the reservoir watershed was used to provide a standard for water quality). Monitoring was recommended during mine operations and after project abandonment. The effective application of mitigation meant that cumulative effects were not considered significant and would not impact resource users. Similarly, the proposal to dredge or otherwise recover the timber submerged during the creation of the reservoir would only be approved if the impacts were manageable and would not impact resource users when considered along with the mine impacts.

The extent of loss of forest, wildlife and wetland habitat in Tahtsa Reach, a nearby bay formed by the creation of the reservoir, was not easily determined as historic baseline information was unavailable (estimates ranged from 10,000 to 15,000 ha lost). With only a 575 ha footprint, the mine's contribution to regional losses was considered negligible, temporary and mitigable. Furthermore, the proponent must develop reclamation plans to restore or enhance habitat after mine closure. A similar comparison to forestry activities also indicated that these effects in the watershed were not significant unless local spatial and brief time scales were considered and if reclamation was ignored (the latter was not a reasonable assumption given the nature of the forestry activity in the watershed).

Lessons Learned

- The nature of the project and the spatial limitations of potential effects were such that a detailed assessment was not considered necessary. This was in part due to the monitoring and mitigation requirements placed on the mining industry and the successful development of mine plans and design that included abandonment and reclamation.
- The project identified several areas of uncertainty, including lack of original baseline information of pre-Kemano conditions. However, the statistical insignificance of the effects made further assessment unnecessary. The temporal concerns were already regulated and the industry had made major advances in mitigating future impacts. The monitoring required by existing regulation would also adequately address concerns at both local and regional (i.e., cumulative) scales.

TERRA NOVA OFF-SHORE PETROLEUM PROJECT

Case Study Highlights

VECs: Water and air quality, fish, seabirds, marine mammals

Issues: Changes to water quality, impacts on fish, seabirds and marine mammals; reduced opportunities for fishing; impact of noise from aircraft and project activities on seabird colonies and marine mammals

Approaches: Interaction matrices indicating scale, magnitude, duration and mitigation measures for each potential impact on specific development activities and VECs

Lessons Learned: Acknowledgment of lack of information about future offshore projects on the Grand Banks and the difficulty of assessing cumulative effects because of the uncertainties and multi-jurisdictions that are involved; project demonstrated the need for follow-up and monitoring programs supported by many stakeholders

Background

A federal-provincial panel was appointed in 1996 to review and assess an offshore petroleum development southeast of Newfoundland. The project was designed to recover petroleum resources from the Terra Nova oil field located in the northeast section of the Grand Banks. Approximately 1 billion barrels of oil are contained in this reserve. The proponents would use a floating steel monohull production, storage and offloading vessel; semi-submersible drilling rigs; and shuttle tankers to transfer produced oil from the site to storage facilities onshore or directly to markets (Harris et al. 1997). Drilling centres will be located in open glory holes, 10 m deep and 15 m wide, from which flowlines trenched in the ocean floor will carry oil to flexible risers leading to the production platform.

Assessment Approach

The principle cumulative effects issues identified were: impact of discharging drilling muds, cuttings, drilling fluids, deck waste and produced waste on water quality, fish and fish refuge, and marine mammals; impact of oils spills on water quality, fish and fish refuge, and marine mammals; impact of noise from aircraft and project activities on seabird colonies and marine mammals; impact of project activities on the fishing industry; and potential impacts on VECs from the existing Hibernia project and all other potential developments on the Grand Banks. Only factors specific to planned petroleum projects on the Grand Banks throughout the life of the Terra Nova Development were included in the assessment.

Within the proponent's CEA, all possible relationships between project activities and VECs were identified in interaction matrices. Impacts were evaluated after consideration of mitigation measures that were designed into the Terra Nova project and its operational procedures. Results were tabulated for the VECs which included an assessment of the magnitude, scale and duration of potential impacts. The majority of impacts were evaluated as negligible; however, a limited number were rated as moderate to major with respect to noise disturbance to seabird colonies. The proponent stated that with development-specific mitigation measures and monitoring programs these impacts would be reduced to negligible levels.

With respect to cumulative impacts resulting from potential developments and other projects on the Grand Banks, the proponent did not include future activities in the assessment because of the lack of detailed information on their likelihood, timing and scale (Petro Canada 1996). The assessment did address potential cumulative effects from the Hibernia project, the commercial fishery and commercial shipping. Resulting impacts from these activities were determined to be insignificant because the distance between the Terra Nova project and Hibernia would be sufficient to avoid overlap of effects; in the future the two projects would investigate shared logistics to reduce the impacts caused by aircraft and shipping vessels; and the safety zones of the two developments would be large enough to provide a potential refuge for the fisheries and allow for unimpeded fish harvesting.

Within its report, the Panel stated that it was not possible to hold the proponent responsible for potential developments beyond their control that may interact with the Terra Nova project to cause cumulative effects. However the Panel did stress that gradual accumulative degradation of the Grand Banks environment due to collective anthropogenic impacts was a major environmental concern and must be avoided (Harris et al. 1997). Without sufficient information and a defined methodology to identify and measure impacts, the Panel found it difficult to assess the cumulative effects of the project. The multiple jurisdictions involved in the assessment added to their difficulty and it was evident to the Panel that it would be necessary to have cooperation between all stakeholders in order to complete a comprehensive cumulative effects assessment.

Recommendations by the panel to address cumulative effects included the development of a workshop of experts with experience in environmental monitoring, sampling and measurement to examine the potential for cumulative effects of petroleum developments and other activities in the Newfoundland offshore environment and to design an approach to monitor these effects. Once a cumulative effects monitoring program was established, all offshore development projects would be required to incorporate this monitoring program into their individual monitoring plan standards and measures.

Lessons Learned

- It was difficult to assess cumulative effects of the Terra Nova offshore project because of the uncertainties and lack of information regarding the number and magnitude of future offshore petroleum developments and other activities on the Grand Banks; and the multi-jurisdictions involved in the assessment.
- Due to the present difficulties in identifying and measuring cumulative effects; the Panel recommended a follow-up monitoring program be developed, implemented and supported by multi-stakeholders for all future offshore developments on the Grand Banks.

EAGLE TERRACE SUB-DIVISION

Case Study Highlights

VECs: Elk, wolf, Swainson's Thrush

Issues: Loss of critical winter habitat, obstruction of regional wildlife movements

Approaches: Calculation of incremental land lost (direct and indirect) using a GIS due to changes between successive development scenarios

Lessons learned: Spatial boundaries based on available digital base-map; limitations of interpreting long-term ecological implications of changes

Background

In 1996 a proposal was submitted to the Town of Canmore in Alberta for the development of the 67 ha Eagle Terrace residential subdivision. The project would adjoin existing sub-divisions near the town, located in the Bow (River) Valley east of Banff National Park. Parts of this valley have experienced extensive human development since the beginning of this century. Continued growth in tourism has increased demand for resident and visitor facilities, resulting in development pressures for housing. This urban growth, combined with a major national transportation corridor (i.e., four-lane highway and a railway) has disturbed the important montane ecosystem that supports a wide variety of wildlife species and plants. Concerns were raised about the cumulative or nibbling loss of wildlife habitat in the mountain valley, and the obstruction of wildlife movement corridors as developments continue to advance up the lower slopes of the valley.

Assessment Approach

An EIA of the project was prepared which included a CEA chapter (Eagle Terrace 1996). The assessment method was based on the calculation of available habitat in the valley between successive development scenarios. This allowed the comparison of incremental losses of habitat. Three wildlife species were chosen as indicators: elk, wolf and Swainson's Thrush. Elk was used to assess use by ungulates and to serve as an ecological indicator of use of early seral habitats. Wolf was used to assess use by large carnivores and to serve as an ecological indicator of regional wildlife movements between Banff National Park and areas east of the Park. Swainson's Thrush was used to assess use by songbirds and to serve as an ecological indicator of localized fragmentation of forest habitat.

Ecosites (classifications of vegetation-landscape association that categorize an area based on its soils, drainage, and vegetation characteristics) were used to create a habitat base map that provided input into a GIS. The map defined a regional study area of approximately 17,000 ha, which extended west from Canmore to the boundary of Banff National Park, and east to the eastern edge of the Rocky Mountains. Twenty-four ecosites were interpreted, based on their suitability for providing basic wildlife habitat requirements (e.g., cover, forage), into three habitat suitability ratings (low, moderate and high) for both summer and winter.

The Eagle Terrace site was mapped along with other existing developments, foreseeable projects (i.e., those under application for approval or approved), and various infrastructure such as roads and railways. To represent loss of habitat due to alienation effects (i.e., due to sensory disturbances such as noise and light), an "alienation buffer" was defined for each indicator species. These buffers, which surrounded all disturbances, were 500 m for elk, 1000 m for wolf and 600 m for Swainson's Thrush.

Four development scenarios described changes in the valley. Each scenario was defined by a combination of habitat suitability and level of development, and represented a "snapshot" in time of the condition of the human and natural environment. The first scenario, Pristine, was represented by current valley conditions with all developments removed. The second scenario, Current, represented the existing Bow Valley with its current settlements, roads and other developments. The third scenario, Reasonably Foreseeable, included all developments in the Current scenario and projects which were already under construction or for which there was considerable likelihood that they would occur. The final scenario, Full Build, added the Eagle Terrace development to the last scenario.

Direct habitat loss (due to the overlap of various disturbances on the habitat suitability map), indirect habitat loss (due to the alienation buffers), and total or effective loss (i.e., direct and indirect) were determined for summer and winter habitat conditions. Losses were determined between each of the scenarios. The final calculation therefore provided an indication of the relative contribution of Eagle Terrace to changes in the valley. This contribution could also be compared to changes that had already occurred due to other projects.

It was determined that the Eagle Terrace project would incrementally contribute a small loss of montane and wildlife habitat relative to the losses that already had occurred. In general, existing developments contributed to a loss of 21% or 2789 ha of the important montane ecosite, while the Eagle Terrace development represented 2% of that loss. A large proportion of the most important habitat (i.e., high suitability in winter) was found to already have been lost: 59% for elk, 81% for wolf and 87% for Swainson's Thrush (see table below for an example of how the results were presented). The Eagle Terrace project contributed to less than 1% of this change. The implications of these changes on regional wildlife populations is avoidance of the area by ungulates which make use of the mountain benchlands for winter refuge, avoidance by carnivores which, make use of the valley corridor for regional movements, and avoidance by nesting songbirds.

Summer Habitat Losses for Swainson's Thrush

Scenario	High Suitability			Moderate Suitability			Low Suitability			Total[4]
	Area[1]	%SA[2]	%RA[3]	Area	%SA	%RA	Area	%SA	%RA	
Current	1589	9.4	86.5	6470	38.2	46.9	142	0.8	10.8	8201
Reason. Fore.[5]	175	1.0	70.9	1216	7.2	16.6	0	0.0	0.0	1391
Full Build[6]	0	0.0	0.0	10	0.1	0.2	0	0.0	0.0	10
Total	1764	10.4		7696	45.4		142	0.84		9602

[1] **Area**: area in ha. [2] **%SA**: habitat loss as percentage of total land in study area (16,959 ha). [3] **%RA**: habitat loss as percentage of habitat remaining after last scenario for that habitat suitability class (i.e., High,. Moderate,. Low) (**Note**: The total % is not additive and therefore has not been calculated). [4] **Total**: total habitat loss. [5] **Reason. Fore.**: Reasonably Foreseeable. [6] **Full Build**: represents incremental change due to addition of Eagle Terrace to Reasonably Foreseeable scenario.

Lessons Learned

- The assessment approach provided a quantitative determination of regional level habitat changes due to successive developments and the determination of the relative contribution of the project under review in the future. However (as is still often true in the assessment of effects on wildlife), the ultimate ecological implications of these changes could only be qualitatively determined. It could, for example, be reasonably assumed that losses from existing developments had already considerably contributed to a steady decline in local and regional wildlife populations (corroborated to some extent by field data). This suggested that eventually much of the valley may become permanently alienated to wildlife, or at minimum, result in conditions unlikely to support wildlife populations at historical levels in the valley. That the latter conclusion could not be quantitatively determined indicates the difficulty practitioners experience in translating results from a GIS into the answer ultimately sought; namely, will the wildlife disappear?[33]

- The availability of a digital ecosite map for use in a GIS was a major factor during the determination of spatial bounds. The map included many developments and extended for a considerable distance along the mountain valley, which ensured an adequate representation of natural conditions and human-caused disturbance conducive to a regional level analysis.

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[33] It is notable that no other methodological tool yet exists that may provide a fully confident answer, although the Cumulative Effects Model (USFS 1990) currently used for the assessment of effects on grizzly bear is making considerable advances, especially when combined with the interpretation of genetic data.

TRANS-CANADA HIGHWAY TWINNING PHASE IIIA

Case Study Highlights

VECs: Elk, moose, wolf, coyote, grizzly bear and black bear

Issues: Loss/alteration of wildlife habitat, wildlife disturbance due to alienation, collision mortality of wildlife, and disruption of wildlife movements due to habitat fragmentation

Approaches: Spatial analysis using a GIS to determine loss or reduction of habitat value due to various types of disturbances to wildlife

Lessons learned: Qualitative conclusions and ranking systems are useful to communicate results if supported as much as possible by quantitative analysis that is defensible

Background

In 1994 an EIA was submitted for the proposed twinning of a section (IIIA) of the Trans Canada Highway in Banff National Park, Alberta (Parks Canada 1994). The project consisted of upgrading 18 km of two-lane highway to four lanes and the construction of interchanges. The section to be upgraded was approximately half the distance between the townsites of Banff and Lake Louise, and closely followed the Bow River along its entire length. The Bow River valley forms a long and narrow mountain valley through the park.

The project proponent was Parks Canada, the federal department responsible for that portion of the highway. The project was assessed under the *Environmental Assessment and Review Process Guidelines Order* (the predecessor to the new federal Act). The highway, Canada's major east-west route, required upgrading due to increased traffic volumes (especially from trucking and tourist visitation). The Phase IIIA proposal was able to make extensive use of assessments previously done for earlier Phases I and II, also in the Park.

Assessment Approach

The assessment identified two study areas: the Middle Bow Valley within the immediate vicinity of the highway right-of-way, and the Central Rockies Ecosystem. The areas were 1,150 km^2 and 43,000 km^2 respectively. Most of the analysis was done in the Middle Bow Valley, with the results of that assessment extrapolated to the Central Rockies Ecosystem. A time limit (i.e., temporal bounds) was not defined as the affected environment was assumed to exist indefinitely in a national park.

Environmental components of most concern were wetlands, the river channel, fish-bearing streams, wildlife (particularly large carnivores and ungulates with regional movements), vegetation and fish. The residual effects on wildlife were summarized in the EIA, which preceded the CEA, for nine species and five wildlife categories. Based on these results, vegetation, fish and wildlife were identified as most likely to be affected cumulatively.

The assessment consisted of three parts: 1) screening of other projects and environmental effects (based on the results of the local effects assessment which preceded the cumulative effects assessment), 2) within the Middle Bow Valley, quantitative analysis of effects on six wildlife species and vegetation and a qualitative analysis of effects on other wildlife species and fish; and 3) within the Central Rockies Ecosystem, quantitative analysis of overall habitat loss due to human disturbances.

Cumulative Effects Screening

A project inclusion list of 28 projects and activities was first identified. Linear projects were separated from areal projects due to the different analytical approaches used for each. The projects were screened to determine "which projects are likely to make a measurable contribution to cumulative effects" in the Middle Bow Valley. A screening table rated the likelihood of effects on ten environmental components (i.e., terrain, hydrology, air quality, vegetation, fish, wildlife, recreation, history and archaeology, visual, socio-economic) of various projects, ranked on a 4 point scale (negligible, low, moderate and high). The rankings, qualitatively determined, indicated that wildlife was the most affected environmental component.

Effects on Indicators in Middle Bow Valley

Most of the quantitative analysis was performed on six wildlife indicators: elk, moose, wolf, coyote, grizzly bear and black bear. These were selected based on the availability of data (i.e., life history, movements, population dynamics) and their scientific and public profile. The assessment used available Ecological Land Classification and wildlife data to analyze effects.

Sixteen projects were identified in the screening as possibly contributing to cumulative effects. For each species, the contribution of these projects to cumulative effects were ranked in a matrix against habitat loss/alteration, disturbance due to alienation, collision mortality, and disruption of movements due to habitat fragmentation. The relative contribution of each project to overall cumulative effects in the Middle Bow Valley ecosystem was also ranked. The actual rankings were qualitatively determined, but based on the results of the GIS analysis.

The GIS calculated a series of indices that were based on the degree by which habitat suitability was reduced or lost due to various disturbances. A map of the 16 projects was overlaid on a habitat map for each species. The area of spatial overlap was multiplied by the habitat suitability rating for that ecosite and a modifier specific to the type of disturbance and species being modelled. Modifiers were estimated, based on professional judgement, in recognition of the animal's known behaviour, and in some cases on empirical data. Modifiers were used to represent alienation effects (i.e., "0" represented no disturbance, "5" represented a highly disturbed area), a barrier factor for blockage of movement effects, and a collision mortality factor for death due to collisions with vehicles. A specific distance around disturbances (i.e., "zone of disturbance") was also defined for areas of human use to define a spatial buffer in which alienation effects were expected to occur.

Finally, the total of each index for each species and type of effect (loss, alienation, fragmentation and mortality) was calculated and the incremental changes compared between three scenarios: existing, existing with proposed project, and all possible future projects. The final results were discussed and summarized as qualitative rankings. For example, the results for grizzly bear indicated that: the overall cumulative effect from all activities was "major" (i.e., long-term adverse effects on population in study area), the main contributors to the overall cumulative effect on bear were the existing Trans Canada Highway and the Lake Louise townsite, the incremental effect of the proposed project as a contribution to overall cumulative effects on grizzly bear was "moderate", and two other projects (controlled burns and existing powerlines) contributed to an equal level of incremental effect as the proposed highway twinning project.

Effects of Human Disturbance in the Central Rockies Ecosystem

Areas of human development were mapped at three levels: no and low development, moderate, and high. The density and distribution of three wildlife indicators (elk, moose and bear) were also mapped. Spatial overlap of these maps indicated how severely the cumulative effect of these developments may have already impaired habitat supporting these species. Areas of high habitat potential that were disturbed by areas of high or moderate development were considered of concern. For example, 30% of the Central Rockies Ecosystem had high or very high habitat capability for large carnivores, yet 87% of that area occurred in areas of moderate or high disturbance.

Mitigation

The greatest concern was blockage of movements of bear and ungulates through the park. As mitigation, wildlife underpasses at various points along the highway, and possibly one overpass (i.e., wildlife cross a bridge over the highway) were recommended. However, later evidence indicated that underpasses elsewhere along the existing sections of twinned highway were not used (especially by bears) to the extent originally predicted. This resulted in the recommendation for overpasses only. Furthermore, the effectiveness of the overpasses would be monitored, and fencing along the highway would again be used to reduce collisions and guide wildlife to these crossings. "Carnivore Conservation Areas" were also recommended to ensure that large areas remained undeveloped.

Lessons Learned

- Despite the use of quantitative analysis that provides "precise" numbers, conclusions often had to be made qualitatively. This is generally more true the more complex the effects are, and is particularly true for conclusions about effects on animal species. The numbers provided only one (albeit important and sometimes pivotal) source of information — the balance of the decision based on professional judgement of the assessor and of experts solicited for advice. It is always important, to assist decision-makers in making an informed decision, that an explanation is always provided that describes how such tables of numbers are "translated" into rankings.

- When performing a "quantitative" assessment, care must be taken to fully explain assumptions and uncertainties associated with the derivation of certain quantities. In this assessment, the various modifiers represented a significant source of qualitative input into a "quantitative" analysis. Given the complexities presented in a CEA, this is not in itself unacceptable if the assumptions and uncertainties are explained. At least, upon later examination, reviewers will be aware of the limitations of the method and data used, and weigh the information provided by its conclusions accordingly.

- The presentation of results from the Middle Bow Valley analysis relied on matrices with qualitative rankings and associated qualitative discussion. The presentation of results from the Central Rockies Ecosystem analysis relied on qualitative discussion and GIS maps. This combination of information is useful as the matrices organized results and summarized discussion points. Although the derivation of the matrix rankings were not provided, the results were discussed in detail.

- Performing a CEA in an area under only one principal jurisdiction, such as a National Park, has a significant advantage. This case study had the benefit of relatively well defined land use goals (e.g., from the *Park Management Plan* and other guidelines), data from extensive ecological research, and ready access to the descriptions of other projects and activities in a large regional study area. Most assessments do not benefit from these advantages.

- The mitigation in response to cumulative effects represented two important approaches: 1) implementation of conventional or innovative on-site design modification (i.e., overpasses); and 2) long-term interjurisdictional planning and monitoring on a regional basis to create a forum in which various stakeholders communicate their concerns, support monitoring and reach consensus on land use goals.

TRANSPORTATION CORRIDORS IN GLACIER AND BANFF NATIONAL PARKS

Case Study Highlights

VECs: Scenery

Issues: Degradation of aesthetic qualities of view from highway

Approaches: Comparison of visual images before and after project construction

Lessons learned: Consideration of CEA issues arises from EIAs

Background

Visual effects were assessed for two projects in two of Canada's National Parks during public hearings under the *Environmental Assessment Review Process Guidelines Order*: the twinning (four-laning of a two-lane highway) of the Trans Canada Highway in Banff National Park (FEARO 1979, FEARO 1982a), and the twinning (adding a second track) of the CP Rail main railway line at Rogers Pass in Glacier National Park (FEARO 1982b, FEARO 1983). Cumulative effects were considered because there were existing projects (i.e., highways, railways and some other developments) that could interact with the proposed projects.

Assessment Approach

The Parks are widely regarded for their scenery, and so the scoping process quickly identified visual impacts to be a significant issue. The method used for the Banff project involved a landscape architect who compared photos of the existing highway and predicted views (using sketches) from the same locations after project completion. The method of comparing photos with sketches fully integrates the cumulative effects of everything in the images. The predictions of how the view would appear after construction were based on the design of the reclamation program for the cut and fill slopes. This also allowed the reader of the environmental impact statement to visualize how the project would lead to an improvement of the visual impacts created by the construction of the previous highway. As previous disturbances (i.e., poorly done cut and fill slopes) were being mitigated, the cumulative effect of the twinning project would be an enhancement in the visual quality of the highway. This did not mean that the new project had no effects, but that mitigating existing impacts was an added benefit.

The Rogers Pass project also had the potential to create unacceptable visual effects in locations viewed by travelers along the Trans Canada Highway who frequently stop to admire the scenery. Again, the effects were cumulative with those of the existing railway line. There was also forest harvesting just outside the Park but readily visible from viewpoints within the Park. A photo montage was used to assess visual effects, in which existing photos were compared against retouched photos that simulated the view after the project was completed.

Lessons Learned

- For both projects, the visual effects were determined by methods commonly used by landscape architects. In addition, the landscape architect who did the work was closely involved with the project design team and a number of significant revisions were made to the design to minimize the visual effects. This combination of prediction with mitigation is important in EIA generally.
- The EIAs for these projects were completed prior to statutory requirements for assessment of cumulative effects. However, it can be argued that cumulative effects often unavoidably arise and are examined anytime an EIA is reviewed during public hearings. The nature of the

hearing process, with the Panel reviewing and questioning information presented, often results in inquiries being made with cumulative effect's implications.

KEENLEYSIDE POWER PROJECT

Case Study Highlights

Issues: Defining a process for the CEA to follow

Approaches: Inter-governmental workshop

Lessons learned: Process can be summarized as a series of questions; conflicts over process approaches are often more procedural, legal and political than technical

Background

The Keenleyside Powerplant Project includes the construction and operation of a hydro-electric generation facility at the existing Hugh Keenleyside Dam on the Columbia River in south-central British Columbia, and a transmission line to an existing electrical substation near the Canada-U.S. border. This case study examines the process followed under the Canada-B.C. Agreement for Environmental Assessment Cooperation to develop CEA requirements. The process was developed by the Project Committee appointed under the B.C. *Environmental Assessment Act,* which was composed of members from the federal, provincial and local governments and directly affected First Nations (KPC 1997).

Assessment Approach

The potential for difficulties in setting out the CEA requirements was recognized early in the assessment process. Many past projects in the vicinity of the power project have placed the region under stress, and there were several other existing or suspected projects yet to come. It was decided to convene a workshop of federal and provincial officials and a representative of the directly affected First Nations to derive a workable set of CEA requirements. During the workshop, legal and process related issues were discussed, from which a seven step process was developed consisting of a series of questions to direct the CEA inquiry. The seven steps, designed to satisfy the requirements of a screening under the federal Act and of a Project Report under the provincial Act, are as follows:

1. Which direct effects of the project under review are relevant?
2. Which other projects have effects to which these direct effects could contribute incrementally?
3. What is the geographic scope of the assessment regarding direct effects?
4. What is the temporal scope of the assessment regarding direct effects?
5. What is the overall scale of the cumulative effects likely to be?
6. What mitigation could minimize or address the cumulative effects?
7. What are the residual cumulative effects and their significance?

The workshop participants first agreed to each produce a preliminary list of direct environmental effects. While a seemingly straightforward task, a few problems were encountered; for example, establishing a realistic timeline which would allow the identification of direct effects to proceed in parallel with the assessment of cumulative effects, rather than sequentially as would be more logical given the stepwise nature of the CEA approach.

A decision was made to follow the federal approach of requiring the proponent to develop the draft CEA of all the effects, both those under federal and provincial jurisdiction (in the B.C.

process, the proponent supplies the data and information and the B.C. Agencies carry out the CEA). Each jurisdiction would then review and determine the acceptability of the CEA under their legislation. Although the proponent was encouraged to propose a conclusion regarding level of significance, the final determination of the significance of the cumulative effects will rest with the Project Committee.

The last issue resolved during the workshop was which future projects must be considered (i.e., the second question). The decision was that only those projects approved or already in a formal regulatory process (and thus likely to occur) could legally be required for consideration. Participants recognized that certain concerns are associated with this approach — for example, failure to consider all future projects could place the approval of those future projects at risk given the cumulative stresses on the ecosystem.

Lessons Learned

- A principal lesson from this process (which lasted about a year) is that when any assessment process is reduced to its fundamental components, most of the conflicts are procedural, legal or political in nature.
- Most assessments are concerned with the same issues and are amenable to resolution using existing EIA processes as demonstrated in other assessments.
- The Federal/Provincial review concluded that the cumulative effects of the project were adequately assessed and after mitigation found to not be significant. The assessment did reveal one interesting potential advantage to CEA: assessing potential impacts on a wider spatial scale also widens the range of potential mitigative measures to address direct impacts of the project. The contents of the guidelines were also "proven" and have formed the base for CEA reviews of several other projects in the province.

LA MAURICIE NATIONAL PARK HIKING TRAIL

Case Study Highlights

VECs: Timber wolf, black bear, common loon

Issues: Induced effects due to new access

Approaches: Qualitative discussion of "total stress load" on VECs

Lessons learned: Even relatively small local projects may indirectly lead to more regional effects

Background

In 1996 a screening was conducted under the *Canadian Environmental Assessment Act* for a proposed hiking trail in La Mauricie National Park in Quebec. Cumulative effects were examined in a separate study (Béland 1996) after the initial screening was completed.

The park, located northwest of the town of Trois-Rivieres, offers various recreational opportunities for visitors, including hiking, camping, and canoeing. Visitor usage is high (400,000/yr). The park is surrounded by various disturbances, including logging, hunting, farming, resorts, recreational activities, off-road vehicle use and urban development. The proposed trail would provide new public access into a previously inaccessible wilderness area in the northern portion of the park. The trail would be built with a minimum of new facilities in recognition of the conservation goals of that area.

Concerns were raised that trail use might possibly lead to further induced actions such as requests for winter access (the trail was proposed only for summer and fall use) and upgraded facilities. This may lead to disturbance of wildlife of regional importance that are also representative of the park's ecosystem.

Assessment Approach

Two stakeholder workshops were used to solicit advice from various stakeholders. Participants first identified long-term objectives of the park and verified if the trail is compatible with park policy, park management plan, and park zoning (it was). The scoping of issues and VECs relied on results of the earlier completed screening, which indicated that the trail would cause very minor local effects. For example, only a relatively small amount of clearing would be required (10 ha) and the trail itself represented a negligible break in the forest cover. The trail therefore caused minimal habitat fragmentation, but would pose some sensory alienation of wildlife due to the presence of hikers.

The assessment approach was based on qualitatively assessing the total "stress load" on the selected wildlife VECs: timber wolf, black bear, and the common loon. The state of the species' population and trends were described, stressors identified, and the increase in total stress load attributable to the trail was estimated. Existing trends and objectives for each species were then discussed.

The distribution of the wildlife VECs suggested that a regional spatial boundary include the various types of disturbances surrounding the park (e.g., an adjacent multiple use area with recreational and timber harvesting activities). The time of creation of the park 25 years ago was identified as the beginning of the temporal boundary.

A table identified the stresses that may be affecting each VEC. Stresses included recreational activities and facilities in the park, park management activities, activities outside the park (both existing and prior to the park's creation), and "large-scale effects" such as airborne pollutants. The temporal status of each stress was also determined (e.g., past, current, future).

Timber wolf was acknowledged, due to its large regional movements, as the VEC most affected by local and regional habitat fragmentation. Any disturbances in the park contributing to this were considered a possible cumulative effect, as the wilderness park area is one of the last remnants of protected habitat suitable for wolf in the region. Black bears may be attracted to garbage by trail users, and the trail would increase the probability of bear-visitor conflicts. The trail would also provide new access to lakes and possibly threaten loons, especially at nesting sites. Loons were also recognized as being affected by lake acidification and fishing. A user visitation threshold for nesting loon, based on field observation, was suggested at 15 persons/ha/yr, beyond which a decrease in reproductive success could occur.

Various mitigation measures were suggested, including trail use quotas of 50 persons/day, bear proofing facilities, and avoidance of access to loon nesting sites. Monitoring programs for each species were also recommended.

Lessons Learned

- Despite the results of a local effects screening indicating minimal effects, cumulative effects concerns were nonetheless raised about this relatively small project. The concerns were largely that of possible induced effects due to increased visitation and demands for new or expanded infrastructure, possibly leading to adverse effects on important wildlife species.
- Analysis of effects on wildlife at this level of assessment were restricted to qualitative discussion, based on knowledge about regional wildlife, habitat and disturbance conditions.

MINERAL EXPLORATION IN THE NORTHWEST TERRITORIES

Case Study Highlights

VECs: Peary caribou, aboriginal harvesting

Issues: Potential for disturbance of an endangered species (Peary caribou) due to mineral exploration activities, potential for disruption of aboriginal harvesting

Approaches: Screening and community consultation involving groups established pursuant to an aboriginal land claim

Lessons Learned: Benefit of co-management process, advantage of community consultation by proponents early in project development, potential for negative effects resulting from activities below the threshold requiring a land use permit

Background

During 1996, WMC International Ltd. (WMC) proposed to conduct a mineral exploration program around Prince Albert Sound and the Shaler Mountains on Victoria Island, Northwest Territories (WMC 1996). The helicopter-supported exploration program included remote field camp facilities, drummed fuel caches, prospecting, sampling, ground geophysical surveys and geophysical mapping. A drilling program was to occur after completion of regional mapping and surveys. Aber Resources Ltd. (Aber) and Monopros Ltd. (Monopros) were also pursuing exploration activities on the island. Aber's proposed Kuujjua Nickel Project included airborne geophysical surveys and surface sampling (Aber 1996). Monopros proposed to conduct an aeromagnetic survey.

Concern about mineral exploration had been growing on Victoria Island since 1994 when WMC proposed an airborne survey adjacent to Prince Albert Sound. Residents of Holman, one of two communities on Victoria Island, had just agreed to suspend the harvest of caribou north of the Kuujjua River in efforts to protect the endangered Peary caribou. It was expected that there would be an increase in harvest activities south of the River (along the north coast and head of Prince Albert Sound) an area in which WMC proposed to explore during one of the peak harvesting periods. As interest in mineral deposits on Victoria Island increased during 1995, so did the concern of residents about disturbance to caribou during the calving and post-calving seasons, and disruption to Inuvialuit traditional harvesting by exploration activities, including low-level flights associated with aeromagnetic surveys.

An aerial survey of caribou conducted by the Territorial government over western Victoria Island in June 1994 supported residents' concerns during examination of WMC's 1996 program. Caribou cow-calf pairs had been sighted in the Shaler Mountains neighboring the proposed camp site. Permitted and claim areas also covered an extensive area of central Victoria Island including that identified as calving and post-calving habitat.

Assessment Approach

The north-western portion of Victoria Island forms part of the Inuvialuit Settlement Region (ISR) established following signing in 1984 of the Western Arctic (Inuvialuit) Claims Settlement Act (the "Inuvialuit Final Agreement"). As a result of the Inuvialuit land claim settlement, the Environmental Impact Screening Committee (the Committee), Environmental Impact Review Board (the Board), and Inuvialuit Land Administration (the Administration) were established to oversee the environmental assessment of developments proposed for the region. The Committee and Board are comprised of an equal number of Inuvialuit and government-appointed members.

Review of developments proposed for Inuvialuit private lands are the mandate of the Administration. Developments proposed for crown lands within the region must be screened by the Committee which assesses whether the proposed development is likely to have a negative environmental impact on wildlife, habitat, or on Inuvialuit wildlife harvesting. If there is potential for negative environmental impacts it may be referred to the Board.

Through an agreement signed in 1995, the Department of Indian Affairs and Northern Development (DIAND) and the Inuvialuit Regional Corporation requested the Committee to conduct an annual review of mineral activity in the region, and to examine the cumulative effects of prospecting and exploration activities that are below and above the threshold level requiring land use permits.

In 1996 WMC required a land use permit from DIAND to establish a camp and cache fuel on crown lands. This triggered a screening by the Committee and DIAND. Because WMC's area of interest included Inuvialuit private lands, their proposal was also reviewed by the Administration.

The Committee and DIAND did not screen airborne geophysical and aeromagnetic surveys because land use permits were not required. The Administration approved Aber's aerial survey activities that were proposed for areas over Inuvialuit private lands. In the project descriptions submitted to the Committee, WMC, Monopros, and Aber also described activities that were below the threshold level requiring a land use permit.

The local Inuvialuit Hunters' and Trappers' Committees (HTC) are the focal point of community consultation regarding wildlife in the region. In addition, the Holman Joint Land Use Committee, comprised of representatives from the Olokhaktomiut (Holman) HTC, Hamlet Council, the Community Corporation, the Elders Council and the Youth Council was formed in 1995. The Committee encourages developers to consult with the affected community early in the project planning stage to identify local concerns and potential conflicts.

WMC consulted with the Olokhaktomiut HTC and Holman Joint Land Use Committee in January of 1996. Monopros and Aber also consulted with the community. Holman residents requested that no activities occur within a 5 to 15 kilometer band of land along Prince Albert Sound between mid-July and late August to prevent disruption of caribou harvesting activities. The need to minimize disturbance of migratory bird nesting areas and bears, and to avoid important arctic charr spawning areas was also expressed. WMC assured the community that harvesting areas, caribou calving habitat in the Shaler Mountains, and caribou migration routes would be avoided at sensitive times.

The most important concerns raised were the potential impacts of the developments on caribou during the calving and post calving period and on harvesting activities. Each proponent addressed these concerns in their project descriptions. WMC proposed to do a satellite tracking study to monitor the seasonal movements of female caribou in relation to their camp, operations base, and other areas of interest for mineral exploration using satellite telemetry. Activities would also be temporarily suspended to avoid disturbance of wildlife. Pilots were instructed to maintain a minimum of 500 m elevation on ferrying trips to reduce the disturbance to wildlife. Aber confirmed its intent to require pilots to fly at altitudes greater than 300 m above ground level and verified that it would not operate near Prince Albert Sound.

WMC, Monopros, and Aber submitted project descriptions to the Committee including the results of community consultation as required by the Committee's Operating Guidelines and Procedures. The Committee screened the activities in April 1996 and considered:

- the information provided in the project description;

- mapped information showing the footprints of the projects (including camps, fuel caches, and areas of exploration) overlaid with relevant areas of interest identified in the Olokhaktomiut Community Conservation Plan (harvesting areas, cultural sites, important areas for wildlife);
- recommendations and guidelines in species management plans;
- the recommendations of Olokhaktomiut HTC and Holman Joint Land Use Committee;
- Inuvialuit Harvest Study data to assess peak harvesting areas and times;
- the concerns of government fish and wildlife management agencies;
- below permit threshold activities proposed by Aber and Monopro; and
- the knowledge of the Inuvialuit/government-appointed members.

The Committee also solicited comments from various stakeholders.

The Committee decided that the activities proposed by WMC and Aber during 1996 would have no significant negative impact on the environment or Inuvialuit harvesting, provided that the mitigative measures outlined in the project description were implemented. This decision applied only to activities proposed for 1996. The Committee wished to examine any activities proposed for 1997 with the benefit of the information from the caribou research. Both companies were to ensure that Peary caribou would not be disturbed during the calving period. To allow caribou to move out of the area, the Committee recommended that WMC start work at the beginning of July, and that Aber first work in the northern portions of the exploration area while deferring activities in the southern areas until the first week of July.

Although Monopros and Aber's aeromagnetic surveys were not subject to screening they were encouraged by the Committee to maintain contact with the Olokhaktomiut HTC. In addition, it was suggested that they contact the Territorial Regional Biologist to ensure that calving Peary caribou would not be negatively impacted by the aeromagnetic surveys.

Lessons Learned

- The co-management process in the region not only ensures equal participation by Inuvialuit and government in the environmental assessment process but facilitates the exchange of information between the groups.
- Consultation by proponents with Inuvialuit organizations at an early stage of project development enables proponents to incorporate mitigation into their programs to the benefit of the Inuvialuit and proponents alike.
- Potential exists for significant negative effects resulting from activities outside the scope of the Land Use Regulations. For example, aeromagnetic surveys (low-level flights) are recognized as having potential for significant negative effect. Such activities have clear implications for proper consideration of cumulative effects and can be addressed cooperatively through the consultation process.

C CUMULATIVE EFFECTS HISTORY IN CANADA

Since the advent of formal EIA legislation and policy in the 1970s, the evolution and practice of EIA has resulted in both greater detail in technical response and a broadening of expectations placed on the scope of assessments. What became increasingly clear was that conventional approaches to single project assessments would not necessarily dampen broad environmental degradation over many years; namely, the result of cumulative effects. Deficiencies in both environmental assessment practice and legislation did not provide the mechanisms to move practitioners from the examination of local short-term effects to more far-reaching goals such as sustainable development and maintenance of biodiversity.

In the 1970s, Canada's first federal and provincial environmental assessment requirements were promulgated: the federal *Canadian Environmental Assessment and Review Process* and Ontario's *Environmental Assessment Act,* respectively. At the federal level this was a policy and guideline only until 1984 when the Guidelines Order was issued. Although now there were frameworks to conduct environmental assessments, concerns grew regarding approaches to assessments and inherent limitations in their technical practice. Thus began, in the 1980s, a series of initiatives upon which assessments would become firmly established in Canada.

The publication of Beanlands and Duinker's *An Ecological Framework for Environmental Impact Assessment in Canada* in 1983 laid the fundamentals for future assessment practice. This document arguably did more to assist cumulative effects assessments practice than any other single effort by ensuring a solid basis on which to conduct any conventional EIA. In 1984, the federal government created the Canadian Environmental Assessment Research Council to support EIA research. This led to a 1985 joint U.S.-Canada workshop on cumulative effects assessments with proceedings subsequently published separately in the U.S. and Canada (CEARC/NRC 1986). This workshop tackled the subject through the examination of types of cumulative impacts in various environmental systems (e.g., freshwater) and issues related to managerial and institutional limitations. The report also recognized the complexity and uncertainties of approaching the assessment of cumulative effects. Further research was recommended.

In recognition of the growing importance of addressing cumulative effects in Canada and the need for direction, the Council sponsored the subsequent review of research, management and ecosystem components of CEA and the linkages between them (Peterson *et al.* 1987). These efforts led to the identification of specific technical issues requiring clarification (e.g., analysis of pathways, establishing of spatial boundary) and the need to provide practical methods by which to accomplish CEAs. The Council continued to support these efforts (e.g., Lane *et al.* 1988). Meanwhile, various legislated assessments and project reviews were beginning to incorporate the assessment of cumulative effects (e.g., Northern Saskatchewan Uranium Mines, Alberta-Pacific Pulp Mill).

By the 1990s, various long-term regional studies were providing examples of planning approaches to CEAs (e.g., Hudson Bay Programme, Northern Rivers Basin Study, Oak Ridges Moraine Area Planning Study). A national cumulative effects conference in 1994, hosted by the Alberta Society of Professional Biologists, demonstrated that CEA practice was well established, although methodological approaches remained in their infancy (see Kennedy 1994).

By this time, all provinces had legislation or policy for environmental assessments, and the federal process was replaced by the more comprehensive *Canadian Environmental Assessment Act* in 1995. The consideration of cumulative effects was now explicit and mandatory in legislation both federally and in two provinces (British Columbia and Alberta). However, the concept of CEA was also beginning to expand beyond its established role to address the assessment of policy and research, and to provide the technical basis for future land use planning. The federal cabinet agreed (Boulden 1996) that policy, plans or programs would be subject to assessment, a directive that was administratively strengthened by the passage of the Act. This evolution of assessment into the broader Strategic Environmental Assessment was suggested as the "next generation process" of assessment practice by the recent International Study on the Effectiveness of Environmental Assessment, an international study initiated in part by the Canadian Environmental Assessment Agency (Sadler 1995).

Currently, there are three bilateral (federal-provincial) harmonization agreements on environmental assessment in Canada (with Alberta, Manitoba and British Columbia). Other agreements are being negotiated with provincial governments. These agreements are designed to ensure efficiency and avoid duplication in environmental assessment between jurisdictions. Since CEA is not a requirement in all jurisdictions, harmonization becomes a particular challenge.

The 1991 Cabinet Directive on Environmental Assessment of policy in Canada requires that all new federal policies and programs seeking Cabinet approval must consider their environmental implications. This provides an opportunity to apply CEA on a broader and perhaps more useful scale. Approaches are currently being developed; however, due to resource constraints in the public sector, it has not received the attention required to adequately advance its implementation.

Future initiatives at the national level will advance CEA practice by building on lessons learned from "case studies", and summarizing the growing body of assessment theory in support of CEA practice. The key is a broad dissemination of information that is targetted to both practitioners and decision-makers. This may include a second Bi-national workshop or conference on cumulative effects, and continued use of the internet to facilitate the transfer of information (e.g., through a Canadian CEA homepage and conferencing). These efforts could result in new training initiatives for administrators and consultants.

Perhaps the greatest long-term challenge will be the creation of regional land use committees and biophysical/land use databases to assist in the identification of cumulative effects thresholds. The success of CEA practice will ultimately rely on the guidance provided by such efforts, and ensure that the rapidly evolving consensus on CEA approaches can be effectively applied to ensure Canada's sustainable development goals are met. Approaches to assessment of policies and programs are on-going.

Assessment History

D SUGGESTED CEA REFERENCES

This Appendix provides references for the following subjects identified in the Guide with the ■ symbol:

- Analytical Approaches
- Assessment History
- Canadian Environmental Assessment Act
- Case Studies
- CEA Primers
- Definitions and Concepts
- Frameworks
- Indicators
- Regional Planning and Studies: Approaches
- Regional Planning and Studies: Case Studies
- Significance
- Setting Boundaries
- Thresholds
- Valued Ecosystem Components

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